OBSERVATIONS ON THE ECOLOGY AND FOOD HABITS OF THE 'PEARLSPOT' *ETROPLUS SURATENSIS* (BLOCH)

DISSERTATION SUBMITTED BY

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CERTIFICATE

This is to certify that this Dissertation is a bonafide record of work carried out by Kum. Reni K. under my supervision and that no part there of has been presented before for any other degree.

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PREFACE

Explosion of human population and the decreasing food supply from terrestrial sources have diverted man's attention towards the aquatic environment for supplementing his food requirements. Thus, aquaculture has been gaining importance for achieving additional production of proteinaceous food. The continually expanding demand for protein-rich fishery products, the stagnating capture fish production, the risk prone, capital-intensive and technology-oriented deep sea exploitation, the ever-increasing fuel costs, coupled with the need to generate more employment opportunities for the rural traditional fishermen have all created an awareness among scientists, policy makers, fishfarmers and enterpreneurs to evolve new strategies for converting the vast derelict swamps and low lying water bodies adjacent to backwaters and coastal zones into productive fish farms at a comparatively low cost and with the locally available technologies. In view of these factors, it is generally felt that the traditional extensive fish culture practices with minimum inputs is a more attractive, feasible and economically viable solution to increase fish production, rather than to concentrate on an already stagnating coastal capture fisheries or to venture into the uncertain deep sea for exploitation.

The selection of productive strains of fish, crustaceans and molluscs for successful culture in different environmental conditions becomes a continuing process. The endemic Indian Cichilds represented by two species Etroplus Suratensis (Bloch) and Etroplus maculatus (Bloch) are traditionally considered to be suitable species for culture practices. They occur along the coastal tracts of penisular India and in the land-locked brakishwater and freshwater lakes of the country. E. Suratensis, the larger of the two is a delicious table fish considered as important for culture in brackish and freshwater (Bensam, 1993); and considerable attention has been given in recent years through research and development programmes relating to the culture of this fish.

Several workers have dealt with the food, feeding, reproductive behaviour, biology, ecology and culture aspects of this fish. The present study deals with the variations in the feeding habits of four size groups in 3 different natural brackish water systems; as well as the food preference of different size groups in laboratory conditions. This dissertation comprises of the following chapters:-"INTRODUCTION", "MATERIAL AND METHODS", "RESULTS", "DISCUSSION", "CONCLUSIONS" and "REFERENCES". "INTRODUCTION" includes the importance of the study, a resume of relevant literature and scope of the study. A description of the study area, station positions and treatment of data are included in "MATERIAL AND METHODS". "RESULTS AND DISCCUSSION" relates to the environment, hydrological parameters, different items in the stomach contents, food preference etc. "RESULTS AND DISCUSSION" presents the salient features from the analyses of the data and discussion in relation to earlier findings. Various aspects of the findings of the present investigations are given in the chapter " SUMMARY " followed by "REFERENCES" containing the relevant literature cited in the dissertation.

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I N T R O D U C T I O N

Aquaculture is the farming of commercially important aquatic animals and plants in fresh, brackish and marine water masses under conditions of husbandary, management, nutrition and breeding. In the world as at present, the day by day increase in human population has drawn more attention to the finite nature of aquatic resources as a source of protein. The trend of production from it, including the sea has reached a stage of stagnation. Thus, it is inevitable to go in for generation of additional resources through culture along with capture, in order to boost protein supply for the ever-increasing human population.

The family Cichilidae is composed of over 100 species of fishes found in fresh as well as brackishwater habitats in Africa, South America, North America and parts of Asia. The larger African lakes of Malawi, Victoria and Tanganyika contain about 500 endemic species of Cichlids (Fryer and Iles, 1972). Their presence in the southern Continents and Islands such as Madagascar and Sri Lanka suggests that although they might have originated in freshwater, their ancestors were able to withstand brackish and marine waters.

Etroplus is the only endemic Indian cichlid genus. Day (1889) has reported three species of *Etroplus* from Indian waters. They are *E. canarensis* (Bloch), *E. maculatus* (Bloch) and *E. suratensis* (Bloch). Of these *E. canarensis* is confined to north Karnataka region. *E. maculatus* and *E. suratensis* are the two widely accepted species and are reported by many workers from Indian and Sri Lankan waters (Jerdon, 1848,; Bleeker, 1863; Gunther, 1892; Day, 1865, 1878, 1889; Munro, 1953; Gunther, 1962).

E. suratensis is distributed widely in brackish and freshwater environments from Goa in the west coast to Chilka lake area in the east coast. It is popularly called the "Pearl Spot", on account of possessing spot along the lateral line and has been introduced in interior water sheds like dams and natural freshwater lakes from early times. The erstwhile Fisheries Department of the Government of Madras has transplanted this species into the interior districts of Bellary and Anantpur and in the farms at Sunkesula and Ippur(Nellore), where it has established itself. (Jones and Sarojini, 1952).

Fingerlings of this fish have been transplanted successfully from north Karnataka to Mahin creak in Bombay (Kulkarni, 1947) in 1941 and in subsequent years from Sunkesula to certain irrigation tanks of Baroda (Mosses, 1942, 1944).

Fry of E. suratensis from the erstwhile Madras Presidency have been introduced to Bidyadhari area in Bengal (Jaganatham, 1946) and these have attained maturity and spawned successfully there (Job and Chacko, 1947). The fish was introduced then to the Hyderbad State in 1942 from Madras and it has established there also (Rahimullah, 1946). Since this fish has recently assumed considerable importance for coastal aquaculture, it is considered desirable to investigate its food and feeding habits, food preference etc; and hence the present work was undertaken to study these aspects.

The earliest studies on Etroplus in India was on their systematics and distribution. Important among these are that of Day (1888). Several authors who have studied the biology of one or the other species have dealt with the food and feeding habits briefly. Alikunhi (1957) has described the food of E. suratensis and reported that from 19 mm length onwards they feed mainly on zooplankton; but as growth progresses, they feed upon filamentous algae such as Spirogyra and vegetable matter. Bhaskaran (1946) has observed the food habits of E. suratensis youngones from freshwater habitat and reported that they feed mainly on filamentous algae, marginal plants and detritus. Bhaskara (1946), Raj (1916), Sebastian (1942) and Job (1947) have discussed briefly the biology of E. suratensis. Chacko (1949) has dealt with the food and feeding of the fry and fingerlings and concluded that they feed rarely on higher marginal plants, insect larve and filamentous algae. Costa (1983) has made biological studies of the Pearlspot from three different habitats in Sri Lanka. A comparative study of the food of E. suratensis juveniles collected from estuarine and freshwater habitats at Mangalore was made by Devaraj et al (1975). They found that filamentous algae and detritus formed the dominant food item in the stomachs of fishes collected from estuarine waters; but in the fishes collected from freshwater, insect larvae and detritus were found to dominate. The digestibility of aquatic macrophytes by E. suratensis and the relative merits of three indegenous components as markers with daily changes in protein digestibility were studied by De Silva and Perera (1983). De Silva et al (1984) have studied some aspects of the biology of this species and its food and feeding habits from brackish water and freshwater reservoir in Sri Lanka. Gopalakrishnan (1973) while describing the taxonomy and biology of the species, has dealt with the food and feeding habits too. The weed-destroying habit of this species is reported by Gopinath (1948). Job et al (1947) have studied it's biology from freshwater tanks, including food and feeding habits. Jayaprakash (1980) in his work on the biology of E. suratensis has studied the food and feeding habits of different size groups of the species, collected from Veli lake in Trivandrum. He found that there is a gradual change in food preference as growth progresses from diatoms and zooplankton to filamentous algae and then to higher aquatic plants. Jayasinghe et al. (1985) have conducted feeding experiments on fingerlings of some cultivable fishes using two formulated feeds. Kezhava et al (1987) studied the feeding habits of E. suratensis in the Netravati-Gurpur Estuary. Mohobia (1987) in his studies on Indian Cichlids has evaluated the biochemical composition of E. suratensis and E. maculatus. Pillay & Hora (1962) have observed that adults of E. suratensis are herbivorous, feeding on Chlorophyceae, Cyanophyceae and decaying organic matter. Prasadam (1971) in his studies on the bilogy of E. suratensis in Pulicat Lake has reported that the fish is mainly a vegetable feeder with seasonal variations in feeding activity. According to him, smaller size groups predominantly feed on microvegetation and larger size groups utilise mainly macrophytes.

Premjith et al (1987) have made a comparative study of the biochemical composition of the stomach contents of E. suratensis and Tilapia mossambica. Padmanabhan (1980) observed the food and feeding habits of E. suratensis. Raj and Sundara (1916) in their studies on freshwater fishes of Madras Presidency have briefly dealt with the food and feeding habits of E. suratensis. Sebastian (1942) has studied the role of E. suratensis and E. Maculatus in the control of mosquitoes. Thampy et al (1987) studied the growth, survival and production of E. suratensis from brackishwater ponds. Varghese (1975) has briefly dealt with the food and feeding habits of E. suratensis in his studies on the biology, morphology and development of Cichlids in India. He has reported that this species is omnivorous, showing a certain degree of specificity with regard to the food items it consumes and that it displays definite variations in the diet in some months. He has also reported that there is no change in the quality of food between males and females and between 'zero' year groups and adults.

MATERIAL AND METHODS

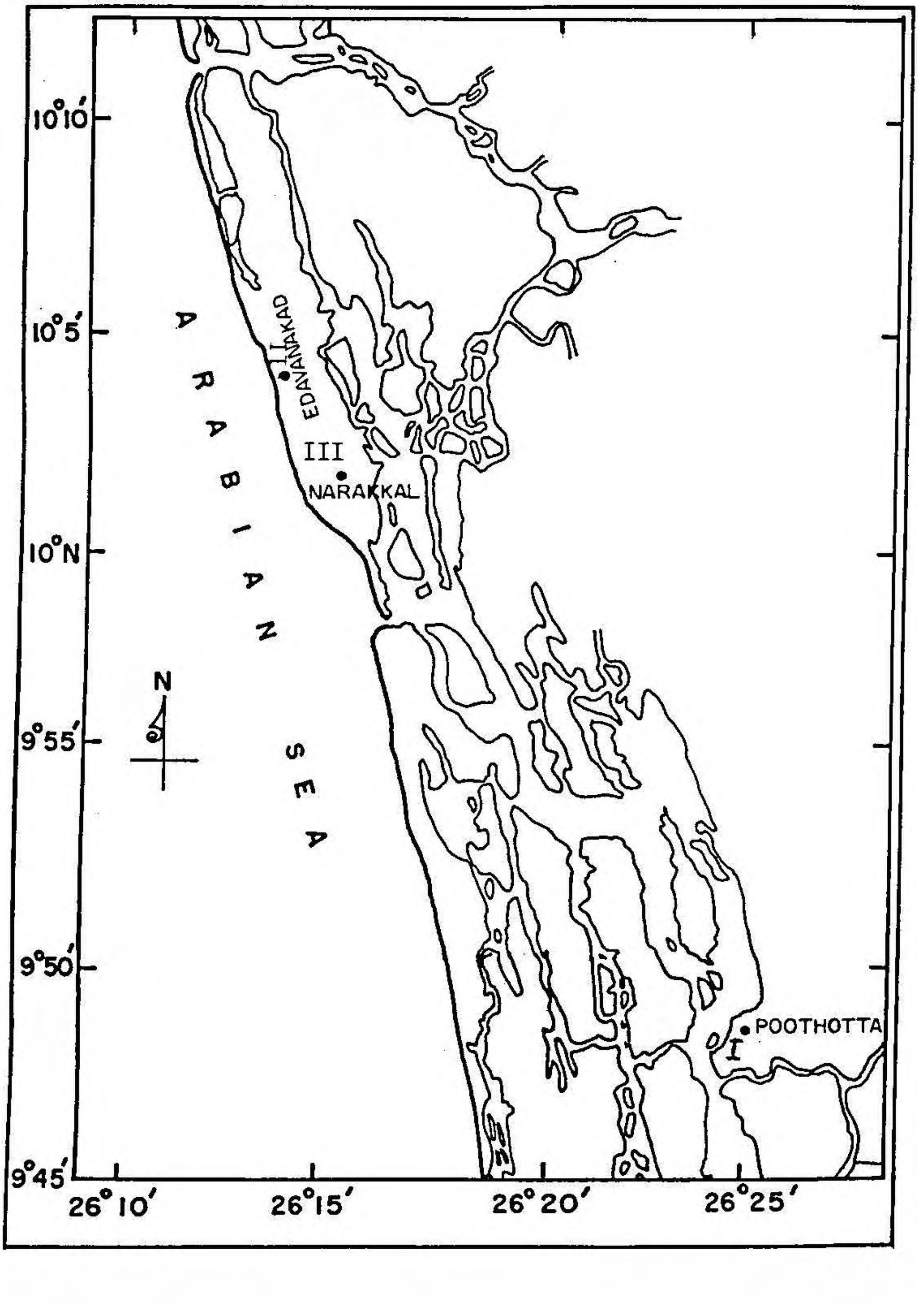
Three representative natural systems were identified for the present study, viz. (i) a brackish water system near the Matsyafed fishfarm at Poothotta, about 72 km south east of Cochin (ii) a brackishwater system near Kannuvilakettu at Edavanakadu about 30 km north of Cochin and (iii) the feeder Canal of Matsyafed fishfarm at Narakkal about 20 km north of Cochin. The fish samples, ambient water and sediment were collected from each station fortnightly. The water and sediment temperatures were recorded at the station itself, using a standard thermometer.

Data on the following parameters were collected from all the three stations.

Ambient water

Temperature
Dissolved oxygen
Salinity
p^H
Nitrate
Nitrite
Phosphate
Silicate

Map showing the location of sampling stations.



STATION I POOTHOTTA

STATION II. EDAVANAKADU

STATION III. (NARAKKAL)

Soil

The upper layer of soil weighing 250 g was collected for a study of the benthos and identification of the algal complex. Algal complexes includes, Blue green algae

Oscillatoria

Nostoc

Diatoms

Pleurosigma

Navicula

Nitzschia

Amphora

Amphipora

Coscinodiscus

Combylodiscus

Microcystis

Merismopedium

Miscellaneous items

Roots of higher plants

Decayed plants and animal matter

Fish egg and fish scales

Microfauna

Copepods

Amphipods

Gastropods

Polychaetes

Collection Methods

Etroplus suratensis of different size groups were collected from each station by using a castnet at fortnightly intervals. For estimation of salinity, pH , nitrate, nitrite, phosphate and silicate surface water samples were collected in narrow-mouthed, screw-capped and airlight polyethylene bottles of 250 ml capacity; and brought to the laboratory after preserving them in an ice box. One litre water was collected from the site in a polyethylene bag and 10 ml of 10% formalin was added to it and kept for settlement. After one week, the upper water was drained off and a known volume of the remaining water with the already settled microflora and microfauna was analysed under a microscope.

For estimation of dissolved oxygen, the surface and bottom water samples were collected in 125 ml glass stoppered bottles, without entangling any air bubble within; and the samples were fixed with 1 ml each of Winkler A and B solutions respectively at the collection site itself. The bottles were shaken gently till a precipitate has formed and brought to the laboratory for analyses.

Temperature

Temperature values of the surface and bottom water were recorded at the collection site itself by a mercury thermometer ranging in values between 0 - 50°C.

Laboratory analysis of fish samples

The specimens of *Etroplus suratensis* were brought to the laboratory for gut content analyses. A total of 25-30 specimens in each size group were examined. After noting the total length, (from tip of snout to the tip of the longest caudal ray), standard length (from the tip of the snout to the origin of the caudal fin) and weight of individual fishes, the specimens were disected out. The feeding intensity and Relative length of gut (RLG) factor of different size groups from the brackishwater environment and difference in the food consumed in different sites with respect to the ecological conditions there were also taken into account. The collected fishes are grouped into four different size groups, viz., 60mm - 89mm, 90mm - 119mm, 120mm - 149mm and 150mm - 179mm. The digestive tract of each specimen was then carefully removed to note the intensity of feeding based on the amount of food present in the stomach and the fishes were grouped, following Prasadam (1971) as:-

empty

¼ filled

½ filled

3/4 filled

full

&

Gorged

The feeding index was calculated using the formula,

$$\text{Feeding Index} = \frac{\text{No. of fishes with filled stomach}}{\text{No. of fishes examined}} \times 100$$

Gut contents analysis

The methods of assessment of food of both marine and freshwater fishes have been evaluated critically by different authors (Hynes 1950, Pillay 1952). The latter has summarised the various methods described by Hynes (1950) into three main categories (i) Numerical (ii) Volumetric (iii) Gravimetric. Numerical method includes (a) Occurance (b) Dominance (c) Number and (d) Point methods.

Due to the presence of diatoms, micro and macro materials and detritus in the gut contents of *E. suratensis*, volumetric or gravimetric estimations could not be satisfactorily adopted for the present study. Therefore the Number method was found to be suitable and convenient over the other methods.

The stomach contents were carefully removed and examined immediately in the fresh condition as far as possible. Otherwise, they were preserved in 5% formalin (Ushakumari and Aravindan, 1992) for subsequent examination. Larger elements were isolated and identified with the help of a hand lens, while smaller organisms were identified using a microscope upto their generic level as far as possible. Gut contents were made up to a known volume and

1 ml of it was taken and analysed; and the number of diatoms, filamentous algae, detritus, digestive organic matter and fragments of higher plants was recorded.

Laboratory analysis of water samples

Dissolved oxygen

Dissolved oxygen content of water samples was estimated by the "Modified Winkler Method" as given by Strickland and Parsons (1968). The already preserved oxygen bottles were added with 2 ml of concentrated Hydrochloric acid and were shaken till the precipitate is completely dissolved. 10 ml of the preserved samples was pipetted out and titrated against Sodium Thiosulphate solution till the blue colour disappears.

Salinity

Salinity of the water samples was estimated by "Mohr - Kundson method" as given by Strickland and Parsons (1968). 10cc of the seawater sample was pipetted out into a 250 cc conical flask. Four drops of potassium chromate solution were added and using a mechanical stirrer, the sample was titrated against Silver nitrate solution.

pH

The pH of water samples was measured in the laboratory, using a digital pH meter. The pH meter was standardised by using buffer solutions of acidic and alkaline solutions. The buffer solution of pH 9.2 was Prepared by dissolving a P^H tablet having p^H 9.2 in 100 ml distilled water and the acidic buffer solution was prepared by dissolving a 4.2 pH tablet in 100 ml distilled water.

Nitrate

The nitrate content is estimated by "Morris and Riley method" as given by Strickland and Parsons (1968). 50 ml of the seawater sample was measured out with a measuring cylinder into a 250 cc conical flask. 2 ml of the buffer reagent was added and mixed well. To this 1.0 ml of reducing agent was added with rapid mixing and kept the flasks away from sunlight in dark place for about 20 hrs. 2 ml of acetone, was then added followed by 1 ml of sulphanilamide solution, after two minutes. After 2 minutes but not later than 8 minutes 1.0 ml of N.N.E.D. solution was added and mixed together and the colour was compared with standard potassium nitrate solution treated similarly.

Nitrate

Nitrate was estimated by the method of Morris and Riley as described by strickland and Parsons (1968). 50 ml of seawater sample was measured out in a conical flask. 1 ml of suphanilamide solution was added to each sample. After 2 minutes but not later than 8 minutes added 1 ml of N.N.E.D. solution to each and mixed immediately. The procedure was carried out with standard nitrite solution also and the colours were compared using spectrophotometer at 543 nm.

Phosphate

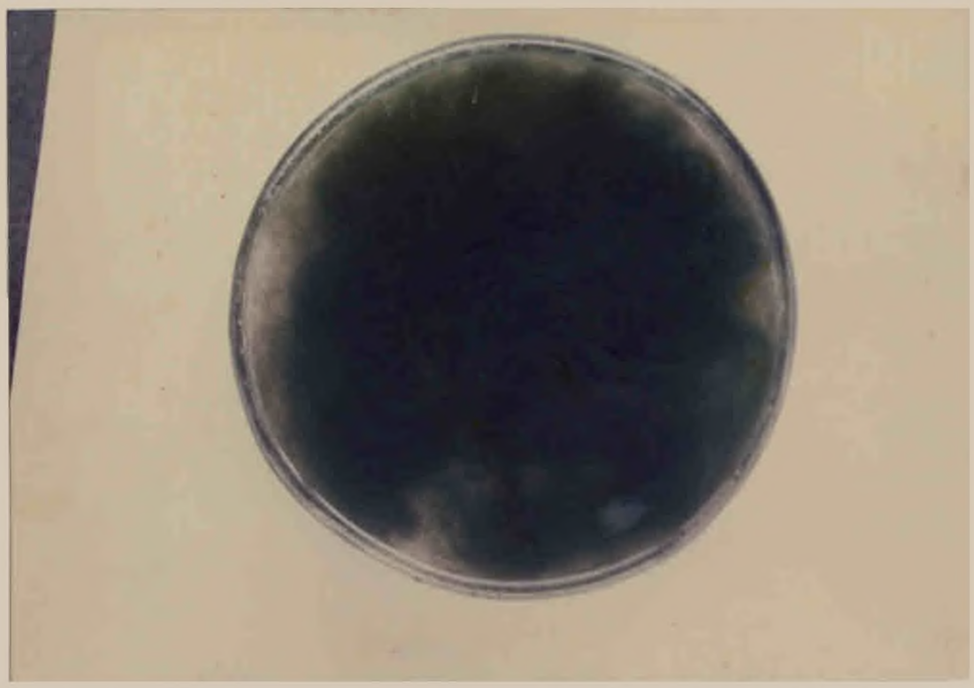
The method given by Murphy and Riley, as described by Strikland and Parsons (1968) was used for the determination of reactive phosphorus. To a 100 ml sample 10 + 0.5 ml of mixed reagent (Molybdic acid, ascorbic acid and trivalent antimony) was added and mixed. After 5 minutes, preferably within 2-3 hours the extinction of the solution was measured at 885 nm. For standard phosphorus, different concentrations of potassium dihydrogen phosphate was made and the graph was plotted. Phosphate is expressed in μg at/l.

Silicate

Dissolved silicon of the sample was estimated by using the method of Mullin and Riley (1955). To a sample of 25 ml, 10 ml of molybdate solution (prepared by dissolving 4g. of ammonium molybdate in 300 ml of distilled water and 12 ml of concentrated hydrochloric acid (12N) was added. After 10 minutes, 15 ml of reducing agent (consisted of metol + oxalicacid + sulphuric acid) was added to the sample. The solution was allowed to stand for 2 hours to complete the reduction. The absorbance was measured against the blank at 810 nm. Standard graph was prepared by using

VARIOUS SIZE GROUPS OF FISHES USED FOR GUT CONTENT ANALYSIS

EXPERIMENTAL SET UP FOR FOOD PREFERENCE EXPERIMENT



FEED I *Spirogyra*

FEED II. *Salvinia*

the standard silicate solution and silicate is expressed in μgat/l.

Feeding Experiments

To find out the food preference of E.suratensis, a feeding experiment was conducted in the laboratory using two weight groups of the fish (4 gm and 20 gm body weight) for a period of 5 days. The fishes were kept in plastic troughs containing 5‰ salinity brackishwater through out the experiment and food materials like Spirogyra, Salvinia clam meat and pelleted feed, prepared from 25% Spirogyra, 25% ground nut oil cake, 20% rice brass, 22% tapioca powder, 2% cod liver oil, 2.8% vitamin mix and 3.2% mineral mix were given to them. The fishes were fed daily in the morning and evening hours at a rate of 10% of the body weight. The unconsumed food and faecal matter were removed from the troughs.

RESULTS AND DISCUSSION

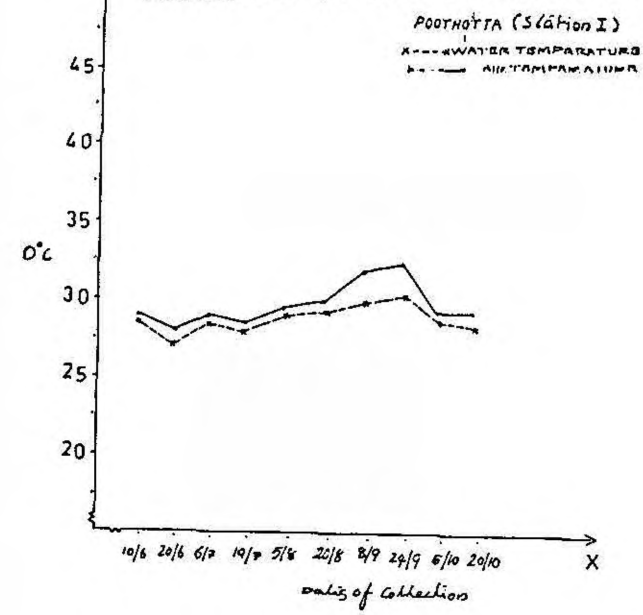
RESULTS

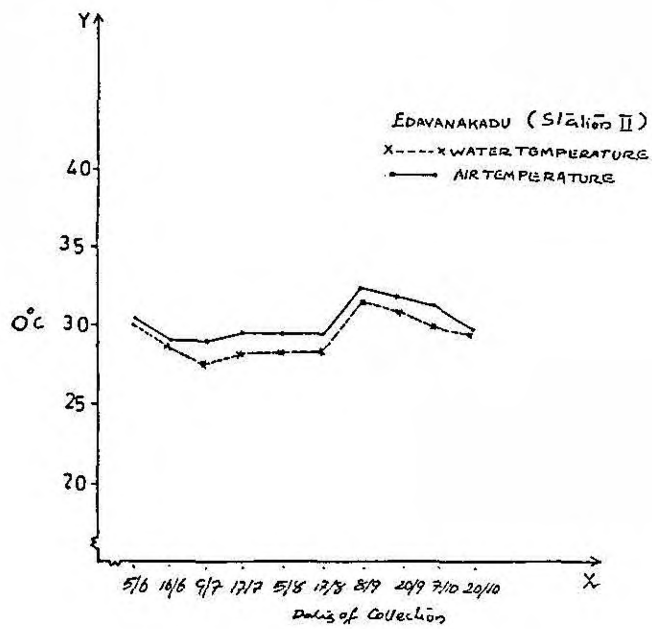
The results of various environmental parameters studied and gut contents analyses made during the period June 1993 to October 1993 are given below.

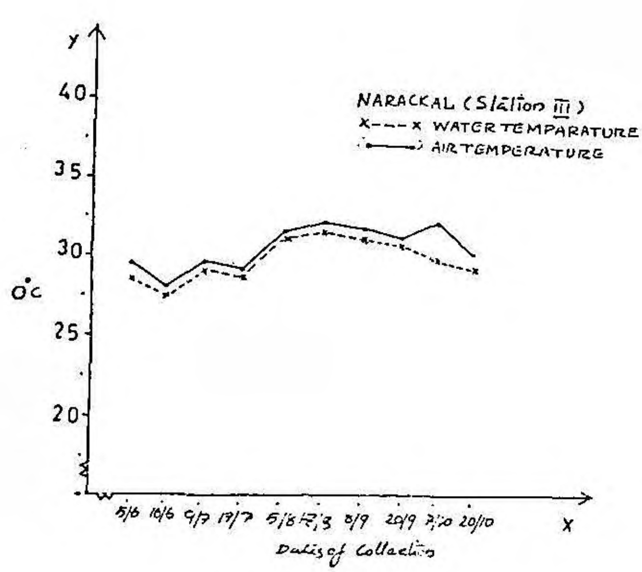
Temperature

The readings made from the samples of ten observations during June - October showed that the variations were more or less similar in all the three stations. In station I (Poothotta brackish water system), the values of water temperature have ranged between a minimum of 27^{o}C in June and a maximum of 30.5^{o}C in September. In this station, air temperature has ranged between a minimum of 28^{o}C in June and a maximum of 32.5^{o}C in September. In station II (Edavanakadu brackish water system), the values of water temperature have ranged between a minimum of 27.5^{o}C in July and a maximum of 31.5^{o}C in September; and the values of air temperature ranged between a minimum of 28^{o}C in July and a maximum of 32.5^{o}C in September. In station III (Narakkal feeder canal near CIBA), the values of water temperature ranged between a minimum of 27.5^{o}C in June and a maximum of 31^{o}C in September; and air temperature ranged between 28^{o}C in June to 32^{o}C in October. (Table-3).

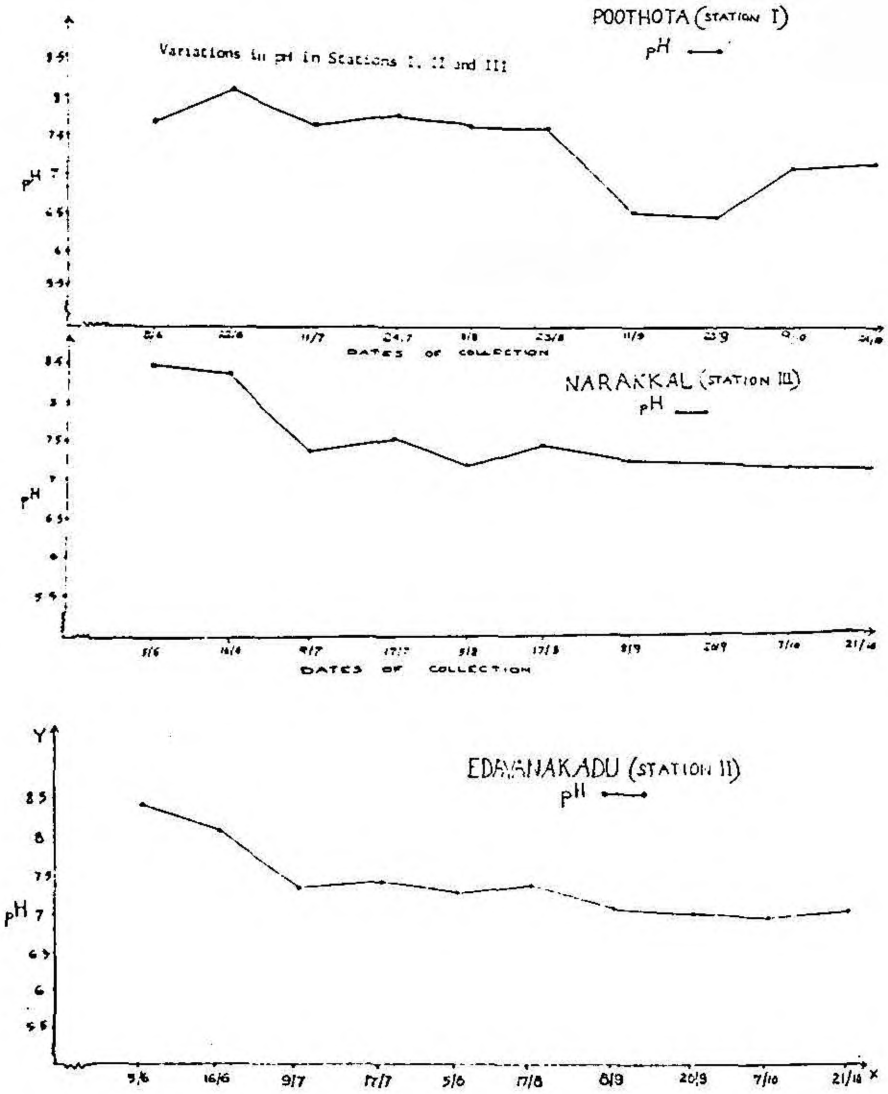
Variations in the air and water temperatures in Stations I,II and III.







Variations in pH in Stations I, II and III



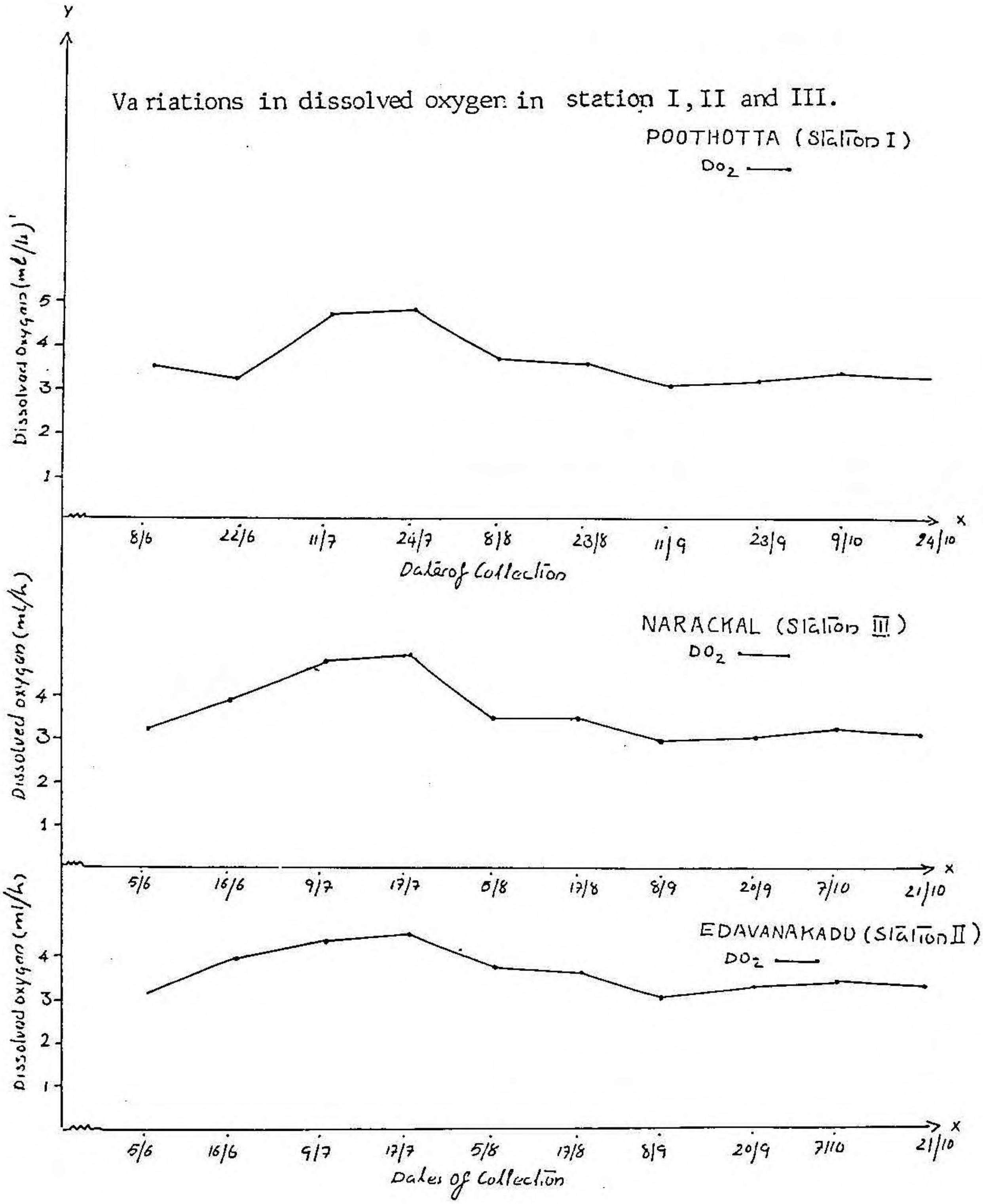

Variations in dissolved oxygen in station I, II and III.
POOTHOTTA (Station I)
DO_2
Dissolved Oxygen (ml/lt)
NARACKAL (Station III)
DO_2
Dissolved oxygen (ml/lt)
EDAVANAKADU (Station II)
DO_2
Dissolved oxygen (ml/lt)
8/6
22/6
11/7
24/7
8/8
23/8
11/9
23/9
9/10
24/10
Dates of Collection
5/6
16/6
9/7
17/7
5/8
17/8
8/9
20/9
7/10
21/10
Dates of Collection

Table 1 Certain hydrological parameters and values of some nutrients recorded from Station I, Poothotta.

	June		July		August		September		October	
	8/6	22/6	11/7	24/7	8/8	23/8	11/9	23/9	9/10	24/0
PH	7.60	8.03	7.09	7.20	7.08	7.05	6.49	6.40	7.03	7.10
TEMP. Water in °C	28.5	27	28.5	28	29	29.5	30	30.5	29	28.5
Air	29	28	29	28.5	29.5	30	32	32.5	29.5	29.5
DO_2 in ml/L.	3.59	3.22	4.73	4.83	3.7	3.6	3.08	3.1	3.48	3.3
Salinity in ‰	0.47	0.48	0.06	0.07	0.44	0.45	0.48	0.49	0.21	0.2
Phosphate in µgat/L	7.20	7.36	6.60	8.60	13.20	14.20	9.26	10.18	11.64	11.22
Nitrite in µgat/L	1.04	1.05	1.40	1.64	0.46	0.70	0.90	0.78	0.90	0.78
Nitrate in µgat/L	13.20	16	11.96	19.36	12.60	17	12.96	10.60	6.02	5.60
Silicate in µgat/L	20.60	26.80	58	56	40.80	57.80	54.60	54	40.20	43

Table 2 Certain hydrologicl parameters and values of some nutrients recorded from Station III, Narakkal.

	June		July		August		September		October	
	5/6	16/6	9/7	17/7	5/8	17/8	8/9	20/9	7/6	20/10
PH	8.50	8.40	7.40	7.55	7.20	7.46	7.25	7.21	7.15	7.13
Temp. Air	28.50	27.50	29	28.50	28.50	29	31	30.50	29.5	29
Water	29.50	28	29.50	29	29	29.50	31.50	31	32	30
$D.O_2$ in ml/L	3.16	3.82	4.65	4.81	3.43	3.42	2.90	3.01	3.24	3.120
Salinity in ‰	4.84	4.85	0.66	0.68	1.67	1.72	1.80	1.79	1.46	1.01
Phosphate in µgat/L	6.60	7	4.02	3.78	14.50	15.62	9.96	0.98	7.08	6.80
Nitrite in µgat/L	1.70	1.80	1.48	1.48	1.44	1.42	0.82	0.96	0.70	0.96
Nitrate in µgat/L	7.50	9	9.24	9.62	6.80	6.02	7.76	9	5.98	6.22
Silicate in µgat/L	35.60	33	16.50	22	30.40	36.40	25.98	26.12	15.88	15

Table 3 Certain hydrological parameters and values of some nutrients recorded from Station II , Edavanakadu.

	June		July		August		September		October	
	5/6	16/6	9/7	17/7	5/8	17/8	8/9	20/9	7/10	21/10
PH	8.40	8.09	7.31	7.44	7.25	7.36	7.01	6.99	6.93	7
Temp. Water	30	28.50	27.50	28	28	28	31.50	31	31	29.50
Air	30.50	29	28	28.50	28.50	28.50	32.50	32	31-50	30
$D.O_2$ in ml/L	3.15	3.96	4.36	4.57	3.78	3.68	2.01	3.31	3.45	3.34
Salinity in ‰	4.72	4.75	0.88	0.61	1.76	1.74	1.92	1.91	1.23	1.10
Phosphate in µgat/L	5.74	6.82	4.02	5.64	16.4	18.04	9.66	9.80	6.40	6.20
Nitrite in µgat/L	1.80	2.20	1.28	1.23	1.22	1.36	1.78	1.42	0.15	0.62
Nitrate in µgat/L	4.80	8.70	7.52	7.50	6.02	5.06	7.82	8.02	9.60	8.24
Silicate in µgat/L	36	34	14	21.40	19.84	25.22	26.02	27.62	14.56	14.02

P^H

P^H values recorded maximum concentration during the month June in station I and minimum during September, from 8.03 to 6.40. The values in station II were slightly higher almost all the days of observations, with a maximum of 8.4 in June and a minimum of 6.93 in October. In station III, the P^H concentration ranged between 8.5 in June and 7.13 in October. (Table-3).

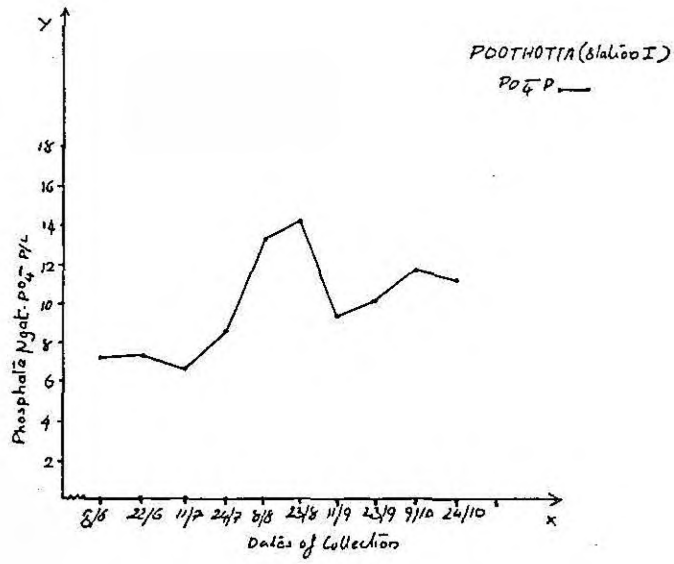
Salinity

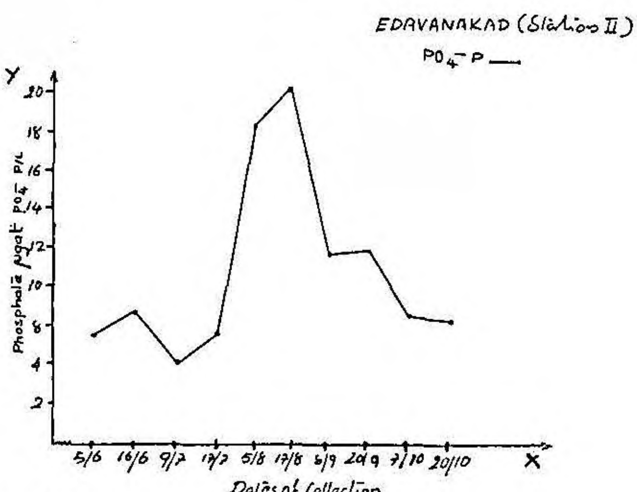
Comparatively very low values were recorded in station I, where a minimum of 0.068‰ was obtained in the first week of July and a maximum of 0.498‰ in the last week of September. In station II, salinity has ranged between a maximum of 4.75‰ in June and a minimum of 0.617‰ in July. In the station III, the values ranged between 4.85‰ in June and 0.664‰ in July. (Table-3).

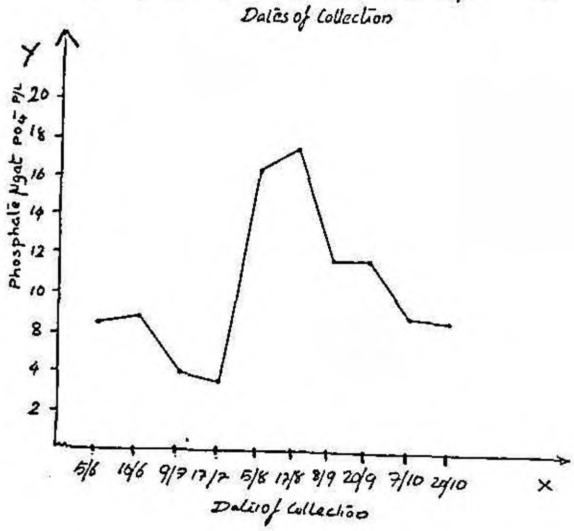
Dissolved Oxygen

At all the three stations, it showed an almost the same trend. In station I, dissolved oxygen value ranged between 4.835 ml/L in July and 3.085 ml/L in September. In station II the range was 4.578 ml/L in July and 3.012 ml/L in September; and in station III, a higher value of 4.813 ml/L in July and a lower value of 2.905 ml/L in September

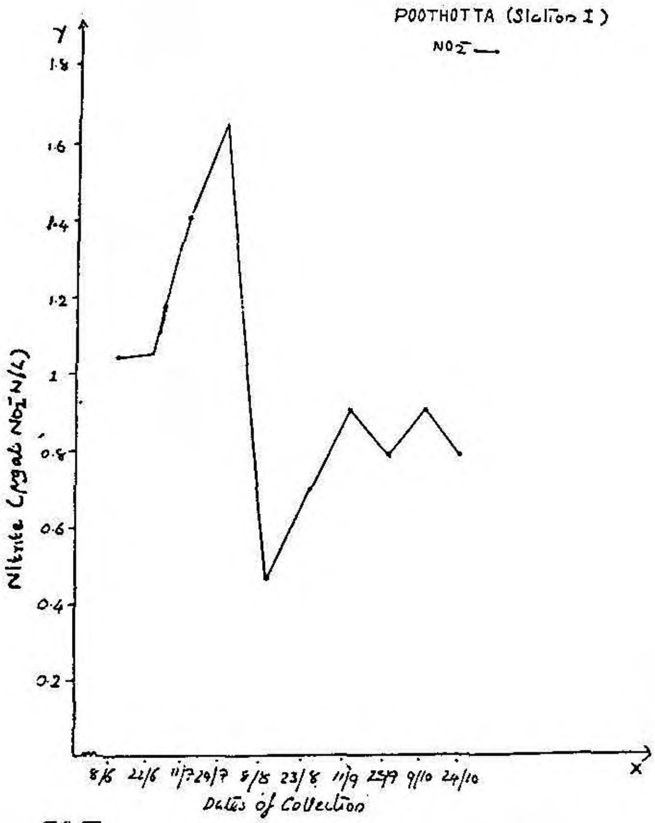
Variations in available phosphate in station I, II and III.

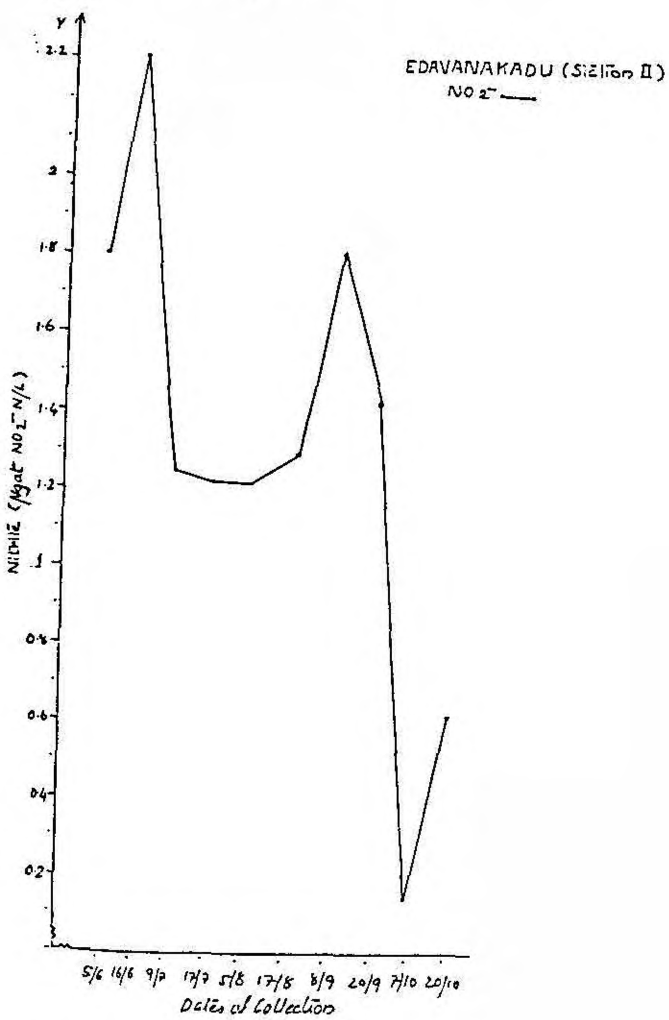


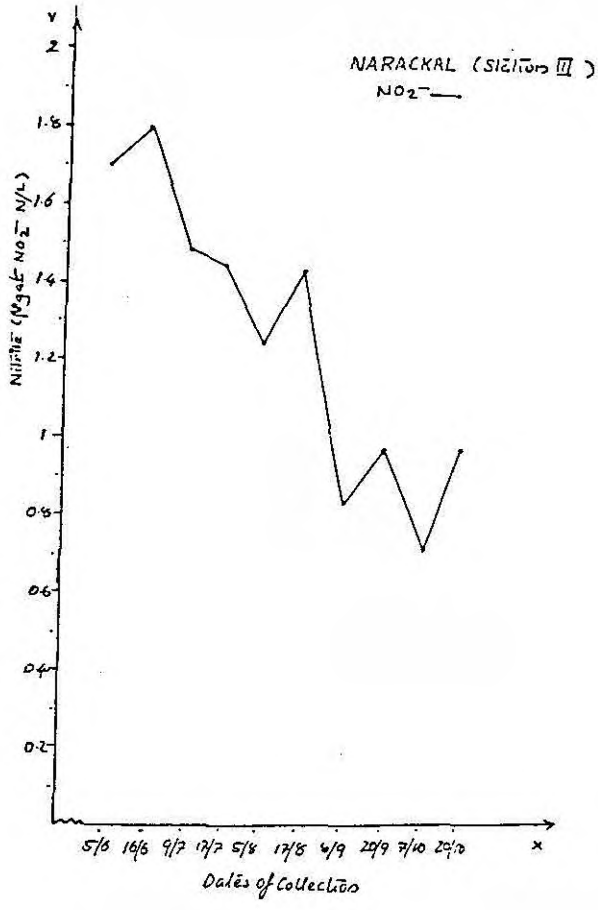




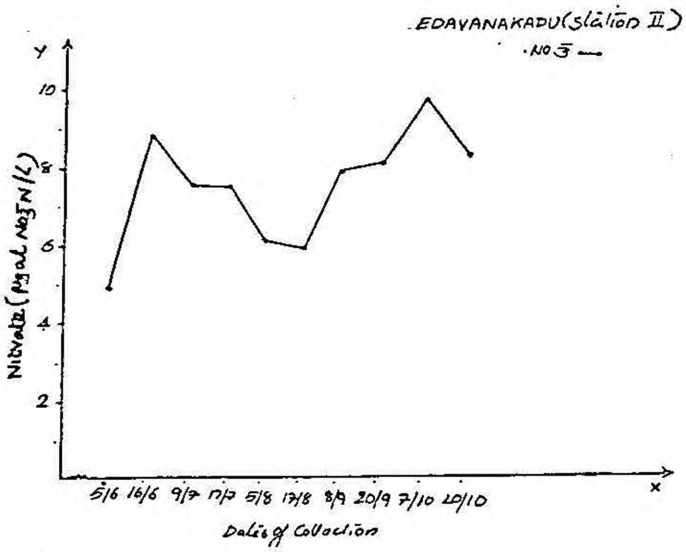
Variations in nitrite, nitrogen in Stations I,II and III

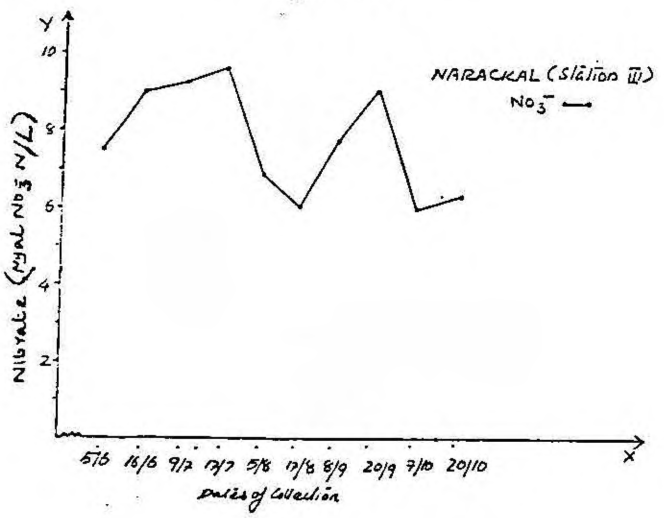


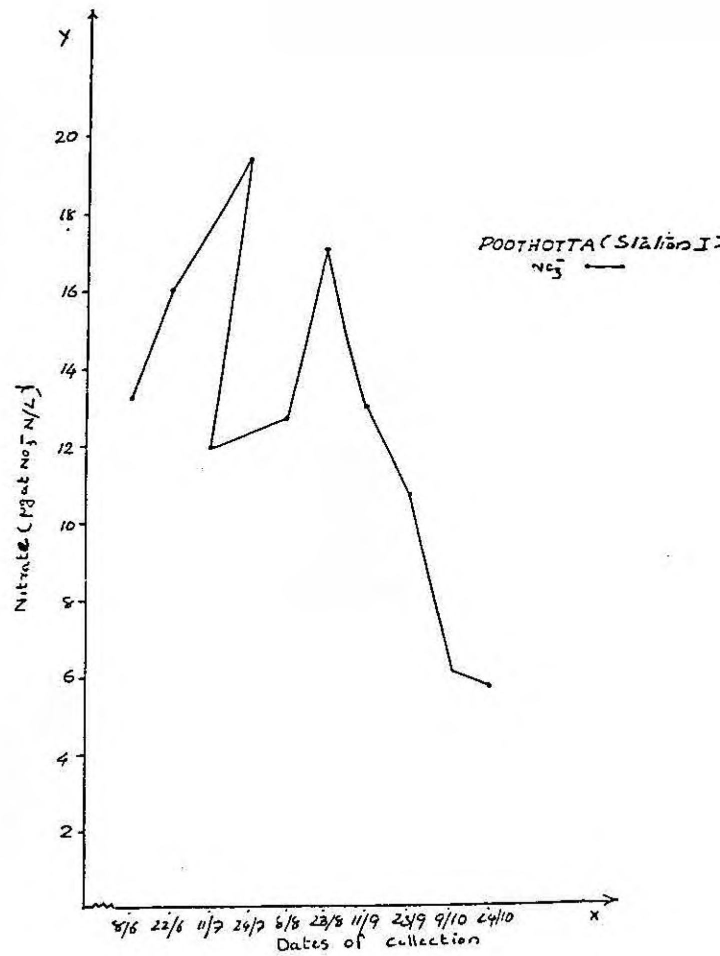




Variations in nitrate, nitrogen in stations I, II and III.







were recorded. In all the three stations during monsoon months the values were high, ranging from 4.578 ml/L to 4.835 ml/L. (Table-3).

Phosphates

Phosphate readings were fluctuating between a maximum of 14.2 μgat/L in August and a minimum of 6.6 μgat/L in July in station I. Phosphate values ranged between a maximum of 18.04 μgat/L in August and a minimum of 4.02 μgat/L in July in station II and the values were between 15.62 μgat/L in August and 3.78 μgat/L in July in station III. (Table-3).

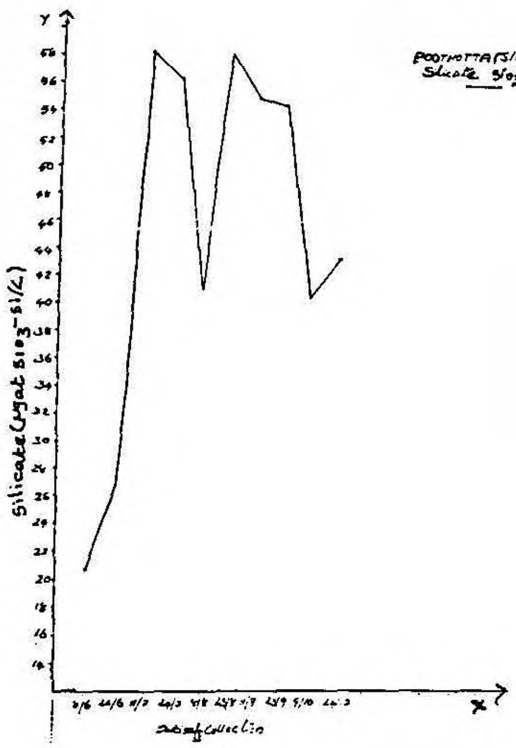
Nitrites

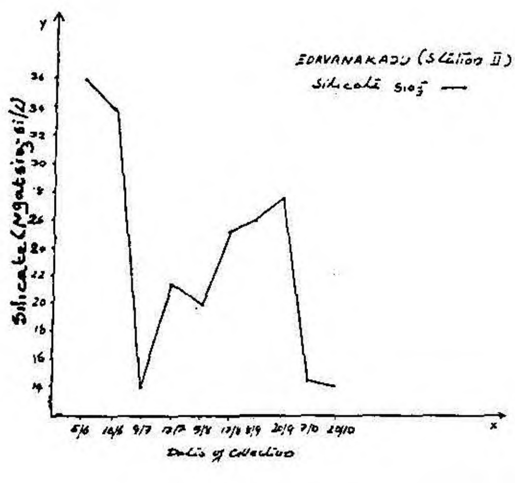
During the study period the values of nitrite was maximum in July in all the three stations. Nitrite values ranged between a maximum of 1.64 μgat/L in July and minimum of 0.46 μgat/L in August in station I. In station II the values ranged between a maximum of 2.2 in June and a minimum of 0.15 μgat/L in October (Table-3).

Nitrates

Nitrate values ranged between a maximum of 19.36 μgat/L in July and a minimum of 5.6 μgat/L in October in station I. In station II, the values ranged between a

Variations in available silicate in station I,II and III.





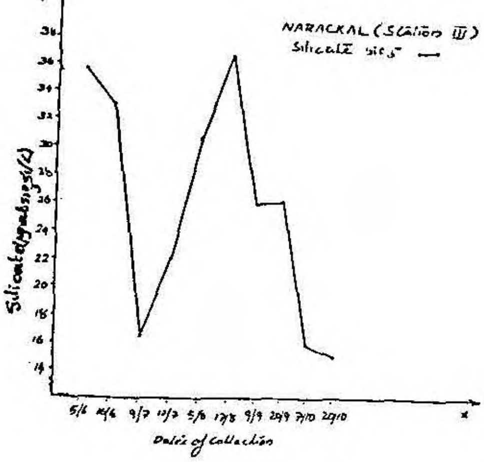


TABLE - 4

Showing the estimated number of various items present in the water (1 litre) and soil (250g.) samples collected from Station I, Poothotta.

	Filamentous algae	Decaying organic matter	Diatoms	Copepods Amphipods Gastropods	Fragments of Higher Plants	Miscella-neous items	Sand grains
June	161700	40300	1499600	-	16400	28900	-
July	181200	415600	1679400	-	16200	31100	-
August	237500	624200	304000	-	29300	159800	-
September	7600	35700	3643000	-	249300	-	-
October	136800	153900	1133000	-	93600	44100	-

maximum of 9.6 µgat/L in October and a minimum of 4.8 µgat/L in June; and in station III these have ranged between 9.62 µgat/L in July and 5.98 µgat/L in October.(Table-3).

Silicates

In station I the values of silicates have ranged between a maximum of 58 µgat/L in July and a minimum of 20.6 µgat/L in June. In station II these were between 36 µgat/L in June and 14 µgat/L in July; and in station III, between 36.4 µgat/L in August and 15 µgat/L in October.(Table-3).

Algal composition in the environment

In each month, an analyses of one litre of water and 250 g of upper layer of soil samples in the three stations, have shown the following constituents.

Station I (Poothotta)

The available phyloplankton genera is given in the Table 4. Bascillariophyceae (Diatoms), Myxophyceae (Blue green algae) and chlorophyceae were the major constituents. Diatoms were dominant through out the study period except during June and July, when filamentous algae like *Oscillatoria* and *Spirogyra* were dominant in the upper layers of soil and water samples. The diatoms present were: *Pleurosigma*, *Gyrosigma*, *Navicula*, *Nitzschia*, *Amphora*, *Amphipora*, *Coscinodiscus*, *Diploneis*, and *Rhizosolenia*. Blue-green algae have included *Oscillatoria* and *Nostoc*.

TABLE - 5

Showing the estimated number of various items present in the water (1 litre) and soil (250g.) samples collected from Station II, Edavanakkadu.

	Filamentous algae	Decaying organic matter	Diatoms	Copepods Amphipods Gastropods	Fragments of Higher Plants	Miscella-neous items	Sand grains
June	162900	43200	1566900	-	17100	29700	-
July	182900	516300	1476900	-	16300	30100	-
August	245700	60300	666000	-	29700	16200	-
September	6300	12300	321300	10800	28400	27000	-
October	878400	565200	3904400	-	394200	-	-

TABLE - 6

Showing the estimated number of various items present in the water (1 litre) and soi (250g.) samples collected from Station III, Narakkal.

	Filamentous algae	Decaying organic matter	Diatoms	Copepods Amphipods Gastropods	Fragments of Higher Plants	Miscella-neous items	Sand grains
June	162900	43299	1566900	-	17100	29700	-
July	175500	87300	373100	-	38800	37800	67500
August	36000	70200	32400	-	47700	55800	40500
September	45900	119700	38700	-	90000	21600	31500
October	62100	40500	24300	-	16200	29700	18900

Detritus, digested matter and fragments of higher plants also were noticed in the water and soil samples. (Table-4).

Station II (Edavanakadu)

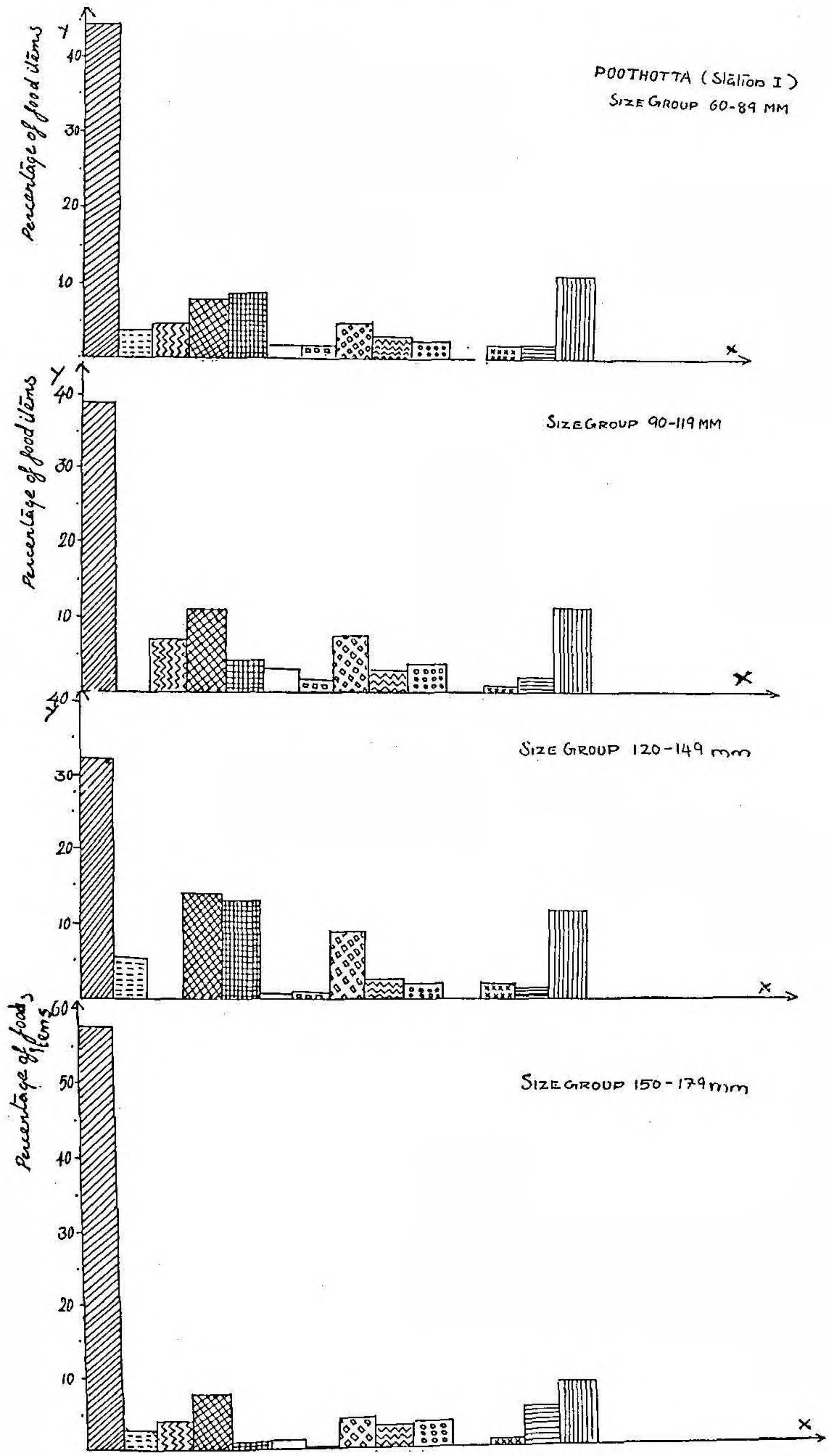
Diatoms were the most dominant item almost through out the study period. Among the diatoms, Pleurosigma, Navicula, Nitzschia and Gyrosigma have occured in abundance through out. (Table 5)

Station III (Narakkal)

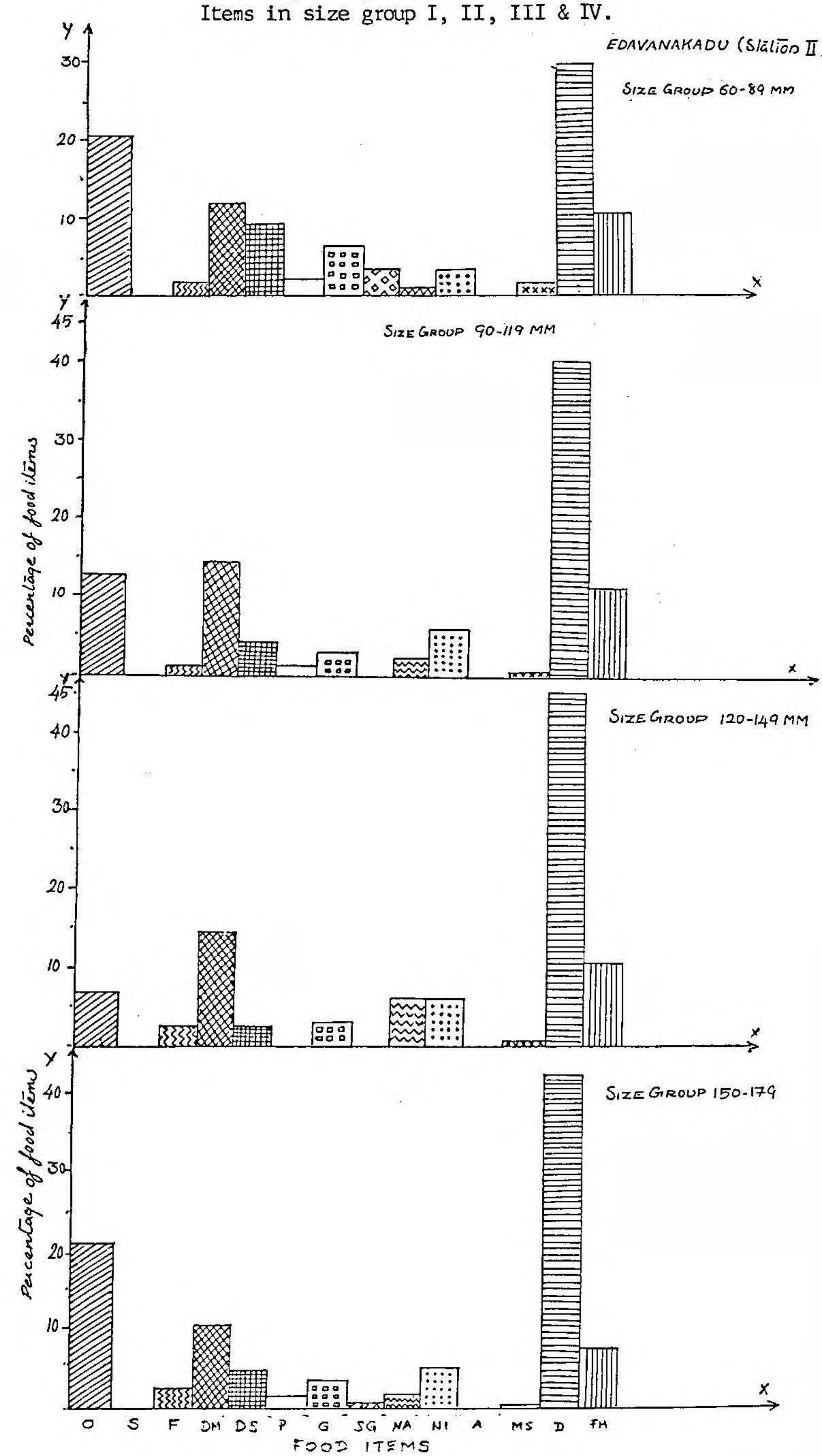
In this station also diatoms were the most dominant item in all the months of the study period. Pleurosigma, Gyrosigma, Navicula, Nitzschia were abundant. The other diatoms appearing in smaller numbers included Amphora, Coscinodiscus, Amphipora, Diploneis and Merismopedium. Oscillatoria was found abundantly in October. In July and August filamentous algae were not recorded. Digested matter, detritus and sand grains have occurred in good proportions in the water samples and soil samples. Miscellaneous items such as roots of higher plants, fish eggs, fish scales and fragments of higher plants were found in good proportions. (Table 6)

Percentage composition of various food

Items in size groups I, II, III & IV.



Percentage composition of various food
Items in size group I, II, III & IV.



Various composition of various food items in size group I,II,III & IV.

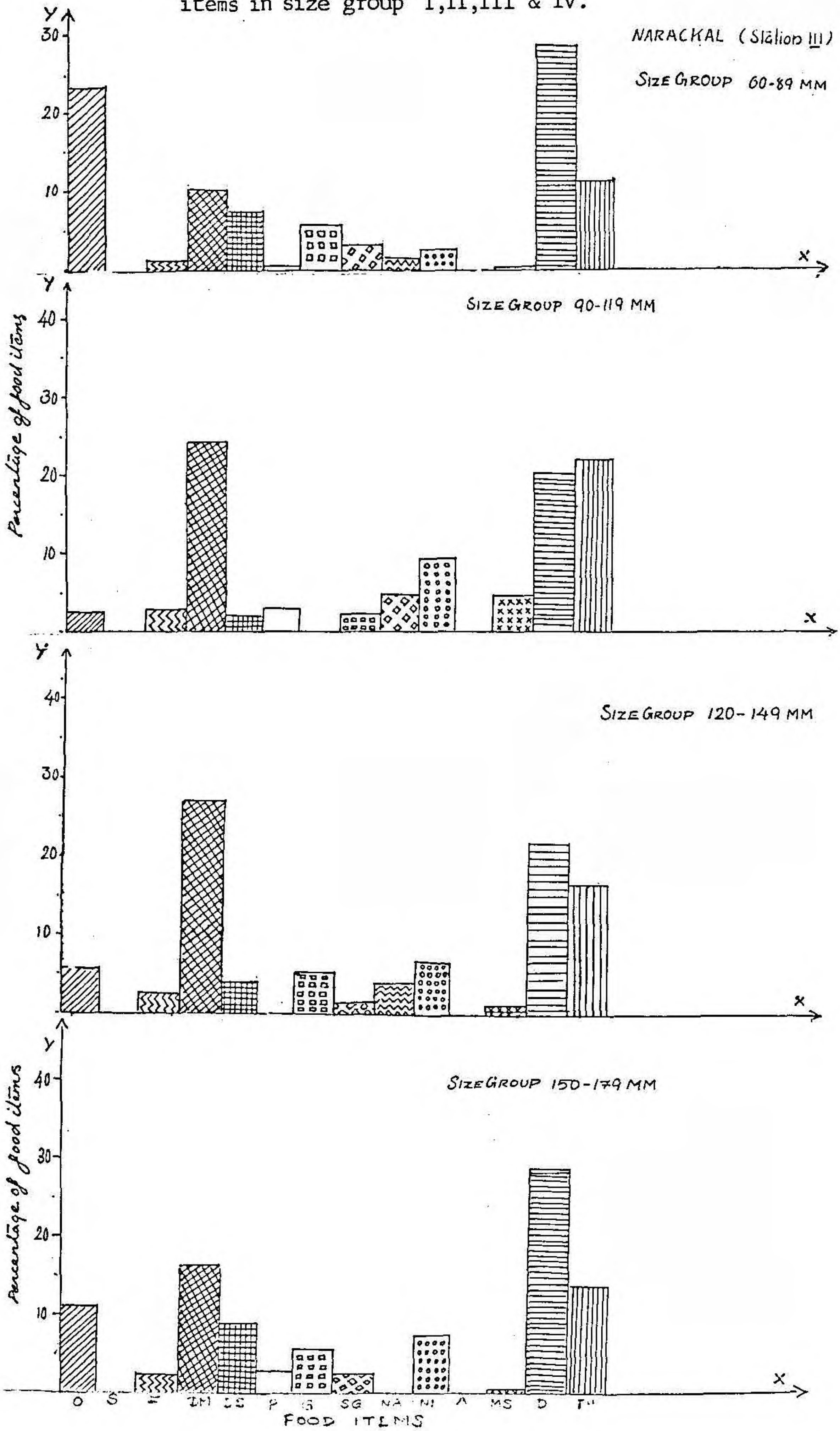


TABLE 13

Percentage composition of food items in the stomach contests of *E.suratensis* of four length groups from Station I (Poothotta)

Length	Group	Fila algae	Digi matter	Detrtus	Diatoms	Copepods Amphipods & Gastro-pods	Frag higher plant	Miscella-neous items	Sand grains
1.	60-89mm	53.16	7.72	8.66	10.38	0.004	11.11	1.49	7.47
2.	90-119mm	46.86	11.01	4.35	14.98	0.006	11.36	1.17	7.96
3.	120-149mm	41.72	13.95	13.09	7.89	0.0005	12.15	2.27	8.92
4.	150-179mm	64.79	7.68	1.28	12.95	0	8.84	0.489	3.97

TABLE 14

Percentage composition of food items in the stomach contents of *E. suratensis* of four legnth groups from Station II (Edavanakkadu) .

	Length Group	Filamentous algae	Digi matter	Detritus	Diatoms	Copepods Amphipods & Gastro-pods	Frag higher plants	Sand grain	Miscellaneous items
1.	60-89mm	22.69	11.94	9.12	41.29	0.0005	10.98	3.59	0.39
2.	90-119mm	14.60	14.71	4.64	52.83	0.0006	11.34	1.17	0.71
3.	120-149mm	9.41	14.59	2.51	61.695	0.0002	10.55	0.74	0.5
4.	150-179mm	23.342	10.38	4.59	53.52	0	7.39	0.64	0.14

TABLE 15

Percentage composition of food items in the stomach contents of *E. suratensis* of four size group in Station III (Narackal)

Length Group	Filamen- algae	Digested matter	Detritus	Diatoms	Copepods Amphipods & Gastro- pods	Fragments of higher plants	Sand grains	Miscellaneous items
1. 60-89mm	25.92	10.58	8.14	39.89	0.0007	11.33	3.89	0.32
2. 90-119mm	5.39	24.32	2.11	39.13	0.0005	22.05	2.27	4.69
3. 120-149mm	7.8	27.01	4.27	41.51	0.0005	15.92	2.17	1.29
4. 150-179mm	13.55	16.05	8.75	44.94	0	13.61	2.59	0.48

GUT CONTENTS ANALYSES

A. Size group I (60-89mm)

The major food items in the stomach contents of *E. suratensis* from Poothotta brackish water system (station I) were filamentous algae, fragments of higher plants, detritus, digested matter, diatoms, copepods, gastropods and amphipods. Filamentous algae have formed 53% of the stomach contents in the samples analysed from station I. Of this, 44% has belonged to blue-green algae and *spirogyra*, *Chara* and *Bulbochaete* have constituted to 9%. Diatoms have formed 10%; detritus, 9%; digested matter, 8%; fragments of higher plants, 11%; miscellaneous items including roots of higher plants, fish eggs and fish scales, 1%; sandgrains, 7%; and copepods, amphipods and gastropods were negligible (Table 13).

In station II (Edavanakadu brackish water system), filamentous algae have formed 23% of the stomach contents in the samples analysed. Of this, 21% has belonged to blue-green algae (*Oscillatoria* and *Nostoc*). Diatoms present have included *Pleurosigma* *Gyrosigma*, *Navicala*, *Nitzschia* *Amphora* *Amphipora*, *Diploneis*, *Coscinodiscus*. The percentage composition was: diatoms, 31% digested matter, 12%; detritus, 9%; fragments of higher plants, 11%; sand grains, 4%; miscellaneous items composed of roots of higher plants, fish eggs, fish scales, copepods, gartropods and amphipods were negligible (Table 14)

In station III (Narakkal feeder canal), filamentous algae have formed 26% of the stomach contents in the samples analysed. The percentage composition was: diatoms, 40%; fragments of higher plants, 11%; digested matter, 11%; detritus 8%; and sand grains, 4%. Diatoms included: *Pleurosigma*, *Gyrosigma*, *Navicula*, *Nitzschia*, *Amphora*, *Amphipora*, *Diploneis* and *Coscinodiscus*. Miscellaneous items including roots of higher plants, fish eggs, fish scales, copepods, amphipods and gastropods were negligible (Table 15).

Preferred food items of Size group I

Based on the above analysis, filamentous algae have formed the major food item in station I and diatoms in station II and III.

B. Size group II (90-119 mm)

Out of the specimens collected from Poothotta brackish water system (station I), the gut contents were mostly composed of *Oscillatoria*, *Spirogyra*, *Pleurosigma*, *Gyrosigma*, *Navicula* *Nitzschia*, *Amphora*, *Amphipora*, *Diploneis*, *Rhizosolenia*, *Coscinodiscus*, detritus, digested matter, fragments of higher plants, copepods, amphipods and gastropods.

Filamentous algae have formed 47% in the samples analysed from station I. Diatoms have formed 15%; Sandgrains, 8%; digested matter, 11%, detritus, 4%; and fragments of higher plants, 11%. Miscellaneous items such as roots of higher plants fish eggs, fish scales, copepods, amphipods and gastropods were negligible. (Table 13).

Out of the specimens collected from Edavanakadu brackish water system (station II), the gut contents were mostly made up of Oscillatoria, Pleurosigma, Gyrosigma, Navicula, Nitzschia, Amphora, Amphipora, Diploneis, Rhizosolenia, Coscinodiscus, detritus, digested matter, fragments of higher plants, sand grains, miscellaneous items including roots of higher plants, fish eggs, fish scales, copepods, amphipods and gastropods. Diatoms have formed 53% of the gut contents in the samples analysed. Filamentous algae have formed 15%; digested matter, 15% and fragments of higher plants, 11%; detritus, 5%; and sand grains, 1%. Miscellaneous items including roots of higher plants, fish eggs, fish scales, copepods, gastropods and amphipods were negligible - (Table 14).

Out of the specimens collected from Narakkal feeder canal (Station III), the gut contents were mostly composed of Pleurosigma, Gyrosigma, Navicula, Nitzschia, Amphora, Amphipora, Oscillatoria, digested matter, detritus, sand grains and fragments of higher plants. Miscellaneous item have included the roots of higher plants, fish eggs, fish scales, copepods, amphipods and gastropods. Diatoms have formed 39%; filamentous algae, 5%; digested matter, 24%; detritus, 2%; sand grains, 2%; fragments of higher plants, 20%; roots of higher plants, fish egg & fish scales, 5%; copepods, amphipods & gastropods were negligible in the gut contents (Table 15)

Preferred food items of length group II

Filamentous algae have formed almost half of the stomach contents in Station I. Diatoms and fragments of higher plants were next in importance. But in Stations II and III diatoms have formed the primary component. In Station II filamentous algae was second in importance. In Station III fragments of higher plants were second in importance.

Length Group III (120- 140mm)

Out of the specimens collected from poothotta brackishwater system (Station I) in the above size group, gut contents were chiefly composed of *Oscillatoria*, *Spirogyra*, *Pleurosigma*, *Gyrosigma*, *Navicula*, *Nitzschia*, *Amphora*, *Amphipora*, *Diploneis*, *Rhizosolenia* digested matter, detritus, fragments of higher plants, sand grains, copepods, amphipods, and gastropods. Filamentous algae have formed 42% of the gut contents in the samples analysed from Station I. Diatoms have formed 8%; digested matter, 14%; detritus, 13%; sandgrains, 9%; and fragments of higher plants, 12%. Miscellaneous items including roots of higher plants, fish eggs and fish scales amounted to 2%; and copepods, amphipods and gastropods were negligible in the gut contents (Table 13).

Out of the specimens collected from Edavanakkadu brackish water system (Station II), gut contents were made up of Pleurosigma , Gyrosigma, Navicula, Nitzschia, Amphora, Amphipora, Oscillatoria, digested matter, detritus, sand grains, fragments of higher plants and miscellaneous items such as roots of higher plants, fish eggs, fish scales, copepods, amphipods and gastropods. diatoms have formed 39%; filamentous algae, 5%; digested matter, 24%; detritus, 2%; sand grains, 2%; fragments of higher plants, 22%; roots of higher plants, fish eggs, fish scales, 5%; copepods; amphipods and gastropods were negligible in the gut contents. (Table - 14).

Preferred food items of length group III (120-149mm)

Filamentous algae have formed half of the stomach contents of samples analysed from Station I. Diatoms and fragments of higher plants were second and third in importance respectively. But diatoms have formed the major constituents in the stomach contents of samples analysed from Stations II and III. In Station II, digested matter and filamentous algae were second and third in importance respectively. In Station III digested matter and fragments of higher plants were second and third in importance respectively.

Length group IV (150-179mm)

Out of all the specimens collected from Poothotta brackish water system, the gut contents were composed of Oscillatoria, Nostoc, Spirogyra, Pleurosigma, Gyrosigma, Navicula, Nitzschia, Amphora, Amphipora, Diploneis, Coscinodiscus, digested matter, detritus, fragments of higher plants, sand grains and miscellaneous items such as roots of higher plants, fish eggs and fish scales. Filamentous algae have formed 65% of the gut contents in the samples analysed from this station. Diatoms have constituted 13%; digested matter, 8%; detritus, 1%; sandgrains, 4% and fragments of higher plants, 9 (Table 13). From Edavanakadu brackish water system (Station II), the gut contents of the speciments were made up of Oscillatoria, Nostoc, Spirogyra, Pleurosigma, Gyrosigma, Navicula, Nitzschia, Amphora, Amphipora, Rhizosolenia, Coscinodiscus, digested matter, detritus, sand grains, fragments of higher plants and miscellaneous items namely roots of higher plants, fish eggs and fish scales. Diatoms have formed 53% of the gut contents in the samplès

TABLE 7

Feeding Intensity of E.suratensis of four
Station I (Poothotta)

Length group	No. of fishes exami-ned	No. of fishes with empty stomach	No. of fish with stomach filled to about 50%	No. of fish with stomach filled to about 75-100%	Feeding intensity
1. 60-89mm	29	0	12	17	58.62
II. 90-119mm	29	7	8	13	48.27
III. 120-149mm	30	6	10	13	46.67
IV. 150-179mm	30	9	8	13	43.33

TABLE 8

Feeding Intensity of E.suratensis of four length groups
Station II (Edavanakadu)

Length Group	No. of fishes examined	No. of fishes with empty stomach	No. of fishes with stomach filled to about 50%	No. of fishes with stomach filled to about 75-100%	Feeding Intensity
I. 60-89mm	29	0	11	18	62.07
II. 90-119mm	29	2	12	15	51.72
III. 120-149mm	29	6	10	13	48.27
IV. 150-179mm	28	10	5	13	46.43

TABLE 9

Feeding Intensity of E.suratensis of four length groups in Station III (Narackal)

Length group	No. of fishes exa-mined	No. of fishes with empty stomach	No. of with stomachs filled to about 50%	No. of fish with stomach filled to about 75-100%	Feeding Intensity
I. 60-89mm	30	2	10	18	60
II. 90-119mm	28	5	7	16	57.14
III. 120-149mm	30	8	6	16	53.33
IV. 150-179mm	30	6	9	15	50

analysed from this station. Filamentous algae have constituted 23%; digested matter, 10%; detritus 5%; sandgrains, 1% and fragments of higher plants (Table 14).

In the samples analysed from Narackal feeder canal (Station III), the gut contents were made up of Oscillatoria, Spirogyra, digested matter, detritus, Pleurosigma, Gyrosigma, Navicula, Nitzschia, Amphora, Amphipora, Diploneis, Coscinodisucs, sand grains, fragments of higher plants and miscellaneous items such as roots of higher plants, fish eggs, fish scales. Diatoms have formed 45%; filamentous algae, 14%; digested matter, 16%; detritus, 9%; sand grains, 3% and fragments of higher plants, 14%. (Table 15)

Preferred food items of length group IV

Filamentous algae have formed about half of the gut contents in the specimens analysed from Station I. Diatoms and digested matters were second and third in importance respectively. Diatoms constituted more than half of the gut contents in Stations II and III, followed by filamentous algae and digested matter.

Feeding Index

Feeding indices of all the sizegroups in all the three Stations.

The feeding indices were: 58.62, 48.27, 46.67 and 43.33 for the size groups I, II, III and IV respectively in Station I. In Station II, the values were: 62.07, 51.72, 48.27 and 46.43; and in Station III the values were: 60,57.14,53.33 and 50. (Table 7 - 9)

TABLE 10

Relative length of gut (R L G) of E.suratensis of four length groups from station I (Poothotta)

Length Group		Average total Length of the fish (mm)	Average gut Length of the fish (mm)	R.L.G.factor
1.	60-89mm	72.413	349.34	481.65
2.	90-119mm	103.97	451.72	435.37
3.	120-149mm	136.83	658.43	482.53
4.	150-179mm	167.17	559.63	336.21

TABLE 11

Relative length of gut (RLG) of E. suratensis of four length groups from Station II (Edavanakadu)

Length Group		Average total Length of the fish (mm)	Average gut Length of the (fish mm)	R.L.G.factor
1.	60-89mm	78.28	386.03	494.19
2.	90-119mm	107.83	460.79	426.99
3.	120-149mm	137.41	662.28	483.05
4.	150-179mm	165.46	566.89	343.55

TABLE 12

Relative length of gut (RLG) of E.suratensis of four length groups from Station III (Narackal)

Length Group		Average total length of the fish (mm)	Average length of the fish (mm)	R.L.G. factor
1.	60-89mm	78	384.73	494.29
2.	90-119mm	110.29	473.46	429.33
3.	120-149mm	137.77	668.77	487.072
4.	150-179mm	166.17	566.43	341.53

Relative length of gut factor (RLG factor)

As may be seen from Table10 in Station I the average total length of the fish in the size group I was 72.4mm, average gut length was 349.3mm and average RLG factor was 481.6. In the size group II, the average total length was 103.9mm, average gut length, 451.7mm and average RLG factor, 435.3. In the size group III, the average total length was 136.8mm, the average gut length, 658.4mm and average RLG factor, 482.5. In the sizegroup IV, the average total length was 167.1mm, average gut length, 559.6mm and average RLG factor, 336.2.

In the Station II (Table 11), in the size group I, the average total length was 78.28mm, average gut length, 386.03mm and average RLG factor, 494.19. In the size group II, the average total length was 107.83 mm, average gut length, 460.8mm and average RLG factor, 427. in the size group III, the average total length was 137.4 mm, average gut length, 662.3 mm and average RLG factor, 483.05. In the length group IV the average total length was 165.5mm, average gut length 566.9mm and average RLG factor, 343.6.

As may be seen from Table- 12 , in Station III in the size group I, the average total length was 78mm, average gut length 384.7mm and average RLG factor 494.3. In the group II, the average total length was 110.3mm, average gut length 473.5mm and average RLG factor, 429.3. In the size group III, the average total length was 137.8mm, average gut length 668.8mm and average RLG factor, 487.1. In the size group IV, the average total length was 166.2mm, average gut length, 566.4mm and average RLG factor 341.5.

STATISTICAL ANALYSIS

From the Factorial Anova table presented in Table-20 , it may be seen that there is a significant difference in the consumption of Oscillatoria by the Pearlspot at different stations at 1% Level. Oscillatoria consumption between Station I (Poothotta) and Station III(Narakkal) has differed significantly; but between Stations I and II and II and III, it is not significant. Between the size groups, Oscillatoria consumption varied significantly between sizegroups I and IV, II and IV and III and IV.

The consumption of Spirogyra by the fish at different stations has varied significantly at 1% level. (Table 21). The consumption of the flamentous algae at different stations has varied significantly at 1% level. Between Stations I and II and I and III, the quality and quantity of consumption had significant differences. Between sizegroups, the consumption between groups I and III, I and IV, II and IV and III and IV had significant differences among themselves.

Consumption of detritus in different stations has significantly varied at 5% level. Consumption of detritus by

TABLE 20

Factorial Anova Table of *Oscillatoria* consumption by *E. suratensis* of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	Value
1	Replication	17	308314147081.482	18136126298.911	0.9110
2	Station	2	189319793003.704	94659896501.852	4.7551**
4	Size Group	3	280068916488.889	93356305496.296	4.6898**
6	Interaction	6	171376890477.778	28562815079.630	1.4348
-7	Error	187	3722643086696.297	19907182281.798	
	Total	215	4671722833748.148		

* Significant at 5% level
** Significant at 1% level

TABLE 21

Factorial Anova Table of Spirogyra consumption by E. suratensis of all the size groups analysed from all the stations.

K Value	Source	Degrees of freedom	Sum of squares	Mean squares	F Value
1	Replication	17	1786395252.315	105082073.666	0.8130
2	Station	2	2330951045.370	1165475522.685	9.0168
4	Size Group	3	447561405.093	149187135.031	1.1542
6	Interaction	6	770196810.185	128366135.031	0.9931
¯7	Error	187	24170806264.352	129255648.472	
	Total	215	29505910777.315		

TABLE 22

Factorial Anova Table of other filamentous algae consumption by E. suratensis of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	14711642931.481	86567231.264	1.8450
2	Station	2	1227618803.704	613809401.852	13.0824**
4	Size Group	3	1318423625.926	439474541.975	9.3667**
6	Interaction	6	1381727351.852	230287891.975	4.9082**
-7	Error	187	8773791168.519	46918669.350	
	Total	215	14173203881.481		

TABLE 23

Factorial Anova Table of digested matter consumption of E. suratensis of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean swuares	F Value
1	Replication	17	18964392785.684	1115552516.803	0.7996
2	Station	2	24906249600.926	12453124800.463	8.9257**
4	Size Group	3	26160845279.167	8720281759.722	6.2502**
6	Interaction	6	9029949513.889	1504991585.648	1.0787
-7	Error	187	260901052131.019	1395192792.144	
	Total	215	339962489310.648		

TABLE 24

Factorial Anova Table of detritus consumption by *E. suratensis* of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	3160239500.000	185884676.471	1.1342
2	Station	2	275282033.333	137641016.667	0.8398
4	Size Group	3	1563283570.370	521094523.457	3.1794*
6	Interaction	6	6561264240.741	1093544040.123	6.6722**
-7	Error	187	30648378588.889	163895072.668	
	Total	215	42208247933.333		

TABLE 25

Factorial Anova Table of Pleurosigma consumption of E. suratensis of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	431366798.148	25374517.538	1.2890
2	Station	2	40379337.037	20189668.519	1.0256
4	Size Group	3	804710218.519	268236739.506	13.6263 **
6	Interaction	6	309621937.037	51603656.173	2.6214 *
-7	Error	187	3681132390.741	19685199.950	
	Total	215	5267210681.481		

TABLE 26

Factorial Anova Table of *Gyrosigma* consumption by *E. suratensis* by all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	4837126950.000	284536879.412	0.7246
2	Station	2	4212092700.000	2106046350.000	5.3629 **
4	Size Group	3	2020732050.000	673577350.000	1.7152
6	Interaction	6	1452614100.000	242102350.000	0.6165
-7	Error	187	73436436450.000	392708216.310	
	Total	215	85959002250.000		

TABLE 27

Factorial Anova Table of *Navicula* consumption by *E. suratensis* of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	3384827853.704	199107520.806	0.9379
2	Station	2	765513359.259	382756679.630	1.8030
4	Size Group	3	2302390805.556	800796935.185	3.7722 *
6	Interaction	6	5019558211.111	836593035.185	3.9408 **
-7	Error	187	39698421990.741	212291026.688	
	Total	215	51270712220.370		

TABLE 28

Factorial Anova Table of Nitzschia consumption of E. suratensis of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	3334209150.000	196129950.000	0.5922
2	Station	2	6100349733.333	3050174866.667	9.2105 **
4	Size Group	3	4495124153.704	1498374717.901	4.5246 **
6	Interaction	6	2775647407.407	462667901 .235	1.3969
-7	Error	187	61927331938.889	331162202.882	
	Total	215	98632662383.333		

TABLE 29

Factorial Anova Table of sand grains consumption by *E. suratensis* of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	2424838231.681	142637543.028	1.2916
2	Station	2	3332546903.704	1666273451.852	15.0882 **
4	Size Group	3	121008938.889	40336312.963	0.3652
6	Interaction	6	653105777.778	108850962.963	0.9856
-7	Error	187	20651510146.296	110435883.135	
	Total	215	27183009998.148		

TABLE 30

Factorial Anova Table of Diatoms consumption of *E. suratensis* of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	166284863820.370	9781462577.669	0.8455
2	Station	2	555399740084.259	277699870042.130	24.0045 **
4	Size Group	3	227929855248.148	277699870042.130	24.0045 **
6	Interaction	6	228317386604.630	38052897767.438	3.2893 **
-7	Error	187	2163335490812.962	11568638988.305	
	Total	215	3341267336570.370		

TABLE 31

Factorial Anova Table of Copepods, Amphypods and Gastropods consumption by *E. suratensis* of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of squares	Mean squares	F Value
1	Replication	17	83.593	4.917	1.2192
2	Station	2	17.287	8.644	2.1432
4	Size Group	3	184.444	61.481	15.2443 **
6	Interaction	6	87.750	14.625	3.6263 **
-7	Error	187	754.185	4.033	
	Total	215	1127.259		

TABLE 32

Factorial Anova Table of Miscellaneous items consumption by E. suratensis of all the size groups analysed from all the stations.

K Value	Source	Degrees of Freedom	Sum of Squares	Mean squares	F Value
1	Replication	17	571423230.708	33613131.218	0.9769
2	Station	2	205155319.083	102577759.542	2.9811
4	Size Group	3	610345440.644	203448480.215	5.9126 **
6	Interaction	6	979750536.731	163291756.122	4.7456 **
-7	Error	187	6434538441.792	34409296.480	
	Total	215	8801213168.958		

TABLE 33

Factorial Anova Table
of Fragments of higher plants consumption by E.suratensis of all the size groups analysed from all stations.

K Value	Source	Degrees of freedom	Sum of squares	Mean squares	F Value
1	Replication	17	9599152150.000	564656008.824	1.6317
2	Station	2	4610228933.333	2305114466.667	6.6610 **
4	Size Group	3	3566274700.000	1188758233.333	3.4351 *
6	Interaction	6	1994967800.000	332494633.333	0.9608
-7	Error	187	64713362150.000	346060760.160	
	Total	215	84483985733.333		

the size groups II and IV and III and IV have varied significantly among themselves. In the case of Pleurosigma, the consumption has varied significantly between size groups II and IV, III and IV and I and IV. The consumption of Gyrosigma has varied significantly at 1% level between Stations I and II and I and III. The amount of sand grains in the gut contents has varied significantly at 1% level, between Stations I and II and I and III. The consumption of Navicula has varied significantly at 5% level, between sizegroups I and III only. (Table 27)

The consumption of Nitzschia has varied significantly at 1% level between Stations I and II and I and III. Among the some groups, the variation was significant between groups I and II and I and IV. The consumption of copepods, amphipods and gastropods has varied significantly at 1% level between groups I and II, I and III, I and IV and II and IV. Consumption of miscellaneous items including roots of higher plants, fish eggs, fish scales, has varied significantly at 1% level between size groups I and II, II and III and II and IV. (Table 28)

Consumption of the minor diatoms (Amphora, Amphipora etc) at different stations has varied significantly at 1% level, between Station I and II and II and III. Between the sizegroups, the consumption has varied significantly at 1% level among I and III, II and III and I and IV. Consumption of fragments of higher plants between stations and between

size groups were varying significantly at 1% and 5% levels respectively, between Stations I and II and I and III. Among the size groups, the above consumption has varied significantly between groups I and IV and III and IV in all
Table 33
the stations. (Table 33)

LENGTH-WEIGHT RELATIONSHIP

The length-weight relationship of fishes is usually represented by $W = aL^b$, where W = weight of the fish, L = Length of the fish, a & b are constant. This expression can be transformed as $\log W = \log a + b(\log L)$. The results obtained from the present study were compared by Analysis of Variance; and the length-weight relationship of _E. suratensis_ at Poothotta (Station I) has been arrived at as: $\log W = -8.96427 + 2.69917 \log L$ with correlation coefficient 0.984360.

At Edavanakadu (Station II), the length-weight relationship is: $\log W = -8.41133 + 2.59632 \log L$ with correlation coefficient 0.987759; while at Narakkal feeder canal (Station III) the values are:
$\log W = -8.63639 + 2.63401 \log L$ with correlation coefficient 0.989601.

FOOD PREFERENCE EXPERIMENT

In the first weight group (20g), the average food consumption from the evening feeding schedule which consists of Spirogyra, Salvinia, pelleted feed and clam meat were:
Spirogyra 1.18g (14.75% of the feed given) Salvinia 0.0013g (.016%) pelleted feed 1,34g (16.75%), and clam meat 1.178g. (14.72%). In the same weight group, the average food consumption from the morning feeding schedule was: Spirogyra 1.144g (14.3%), Salvinia 0.0006g (0.0075%) pelleted feed 1.258g (15.733%) and clam meat 1.132g (14.15%). (Table 16 - 17)

In the second weight group (4 g), the average food consumption from the evening schedule which consists of Spirogyra Salvinia, pelleted feed and clam meat were: Spirogyra 0.316g (15.8%) Salvinia 0.0009g (0.045%), pelleted feed 0.403g (20.15%) and clam meat 0.247g (12.35%). In the same weight group, the average food consumption from morning feeding schedule was: Spirogyra, 0.371g (18.55%), Salvinia, 0.0009g (0.045%), pelleted feed 0.378g (18.9%) and clam meat 0.215g (10.75%).(Table 18 - 19)

TABLE 16

Food preference of four different types of food in weight Group II (20g fish) of E. suratensis, when fed in the evening.

Name of Food Items	Average quantity of unconsumed food in gms.	Average quantity of consumed food, in gms.	Average quantity of in individual fish, in gms.
Spirogyra	3.251	4.749	1.187
Salvinia	7.995	0.005	0.0013
Pelleted feed	2.638	5.363	1.341
Clam meat	3.286	4.714	1.1785

TABLE 17.

Food preference of four types of food in weight group I (20g) of *E. suratensis*, when fed in the morning.

Name of Food Items	Average quantity of unconsumed food, in gms.	Average quantity of consumed food, in gms.	Average quantity of food consumed by individual fish, in gms.
Spirogyra	3.425	4.575	1.144
Salvina	7.997	0.0027	0.0006
Pelletted feed	2.966	5.034	1.258
Clam meat	3.474	4.526	1.132

TABLE 18

Food preference of four types of food in weight group II (4gm) of *E. suratensis*, when fed in the evening.

Name of the Food Items	Average quantity of unconsumed food , in gms.	Average quantity of consumed food , in gms.	Average quantity food consumed by individual fish in gms.
Spirogyra	0.736	1.263	0.316
Salvinia	1.996	0.0036	0.0009
Pelltted feed	0.389	1.6112	0.4028
Clam meat	1.012	0.988	0.2471

TABLE 19

Food preference of four types of food in weight Group II (4gm) of *E. suratensis*, when feel in the morning.

Name of the food items	Average quantity unconsumed food in gms.	Average quantity of consumed food in gms.	Average quantity of food consumed by individual fish in gms.
Spirogyra	0.515	1.485	0.371
Salvinia	1.996	0.004	0.0009
Pelletted feed	0.486	1.514	0.378
Clam meat	1.139	0.861	0.2151

TABLE 34

Feed preference experiment:
Analysis of variance table

K Value	Source	Degrees of Freedom	Sum of squares	Mean square	F Value
1	Replication	7	0.301	0.043	1.8798
2	Station	3	7.173	2.391	104.3914 **
4	Size Group	1	7.049	7.049	307.7788 **
6	Interaction	3	2.375	0.792	34.5605 **
-7	Error	49	1.122	0.023	
	Total	63	18.020		

Statistical analysis by Factorial Anova showed that preference of the four items of feed has varied significantly at 1% level in both the weight groups. The critical difference values showed that generally there was significant difference in the preference of the four feeds, ie between Spirogyra and Salvinia and pelleted feed, Salvinia and clam meat. But, there was no significant difference in the preference of feeds in the morning feeding schedule and evening feeding schedule. In both the size groups, the average food consumed by each fish was more in the caseof pelleted feed than the other items. Spirogyra, clam meat and Salvinia have followed the above in the order of preference.(Table 34)

DISCUSSION

The Cochin backwater system is profoundly influenced by the south-west monsoon, which brings out changes from a marine and brackishwater condition to a freshwater condition during the monsoon rains. The physico-chemical conditions in the backwaters and connected canals are controlled by tides to a great extent. As is well known, the fishery resources of any area is mainly dependent on the magnitude of primary and secondary production which in turn are influenced by physical, chemical and biological factors. In the present study, the atmospheric temperatures have shown little variations. Temperatures were lesser during the monsoon months than during the other months in all the three stations.

Water temperature influences the biochemical reaction and the microbial release of nutrients in the water and the soil. In the present study water temperature was less during the monsoon months than during the other periods. Monthly variations in temperatures observed may be due to the time lag between sampling and the incursion of cold and highly saline water through the barmouth. (Sankaranarayanan and Qasim, 1969). Vijayalakshmi and Venugopalan (1973) while studying the physico-chemical properties of Vellar Estuary have stated that diurnal variations in the surface temperature have followed closely the air temperature and the tidal rhythm. According to Ravindran (1983), the variations in temperature follows the time of the day.

p^H of the water is influenced by soil p^H, concentration of carbondioxide, carbonates and bicarbonates in the water. Phytoplankton and other aquatic vegetations remove carbondioxide from the water during photosynthesis and this results in the rise of p^H. According to (Huet, 1960), the largest fish crops are usually produced in water masses which are just on the alkaline side of neutrality, between p^H7 and 8. In the present study, in Station I, a high p^H of 8.03 was noticed during June and a low p^H of 6.4 in September. In Station II, high p^H 8.4 was in June and low p^H 6.99 was in October. In Station III, the high value of 8.5 was in June and the low value of 7.13 was in October. The low p^H may be due to the increased sedimentation and subsequent reduction of organic debris resulting in relatively more reducing condition near the bottom (Subhash Chander, 1986). Mollah *et al*. (1979) have opined that a gradual decrease in p^H of water and soil might be due to the occurrence of the water hyacinth throughout the surface water, which resulted in an increase of carbondioxide through respiration and decomposition and a decrease in photosynthetic activity. Prasad (1982), Srinivasan (1982). Sugunan (1983) and Singh (1987) while investigating the ecology of certain brackishwater culturesystems near Cochin, have reported high p^H values for water and sediments during the monsoon and postmonsoon. Ravindran (1983) has reported that p^H did not show any seasonal and tidal variations. In the present study, high p^H was noticed during monsoon months in all the 3 stations.

Low salinity values were noticed during monsson months in all the three stations. The precipitation and freshwater discharge into the ecosystem during the monsoon have reduced the salinity, as drawn attention to by Subhash Chander (1986), Prasad (1982), Gopalan et al (1982) Gopinathan et al (1982) and Sankaranarayanan et al. (1982) from certain brackishwater systems around Cochin.

Among the chemical constituents of natural waters, oxygen is of primary importance both as a regulator of metabolic process of plant and animal community and as an indicator of water conditions. Based on a study conducted by Ellis (1937), it is found that dissolved oxygen concentration below 3ppm can lead to asphyxia and that in order to maintain a favourable condition for a varied fish fauna, 5 ppm of dissolved oxygen is required. In the present study in Station I the oxygen values ranged between a high value of 4.835ml/L in July and a minimum of 3.08ml/L in September. In

Station II, the maximum value of 4.578ml/L was observed in July and a minimum of 3.01/L in September. In Station III the maximum value of 4.81ml/L was in July and the minimum of 2.90ml/L was in September. In all the three stations, monsoon months showed higher values than during the other periods. Qasim (1973), Pillai et al.(1975), Gopinathan et al (1984) and De Sousa and Sen Gupta (1986) have observed wide seasonal fluctuations in the dissolved oxugen concentrtions, with high values during the monsoon in estuaries of Cochin and Goa. The present values agree with the above observations. Banerjee (1967) also reported such high dissolved oxygen concentrations 23.4ppm in a pond with thick algal bloom. On the other hand, Nair et al (1988) observed that the dissolved oxygen content of prawn culture fields of Cochin have widely fluctuated with tides and at varying rates of tidal flow.

The distribution of nutrients if largely dependent on the marine influence and the fresh water discharge (Sankaranarayanan and Qasim (1969). Within the onset of monsoon the concentration has suddenly increased. This may be due to the high land drainage and precipitation. The progressive decrease, however, during postmonsoon reaching a minimum can be attributed to biological utlisation (Upadhyay, 1988). In the present study, maximum concentration was recorded during south-west monsoon. the high values noted during the monsoon may be attributed to the freshwater discharge (Sankaranarayanan and Qasim, 1969). Verlencar (1987) is of opinion that seasonal changes in Nitrate-Nitrogen concentration was due to its quick utilization.

Nitrite-Nitrogen may be formed as a result of the decomposition of organic nitrogen and it is a transitory stage in the nitrogen cycle. The findings of Sankaranarayanan and Qasim(1969), Manikoth and Salih (1973), Saraladevi et al (1993) and Nair et al (1988) showed higher values of Nitrite-Nitrogen during the postmonsoon and lesser values during the monsoon.

The interchange of phosphates between sediments and water is known to be one of the major factors governing the phosphate concentration of the overlying water(Subhash Chander 1986). Sediments of estuaries are several times richer in phosphates compared to the overlying water (Moore, 1930) and are reported to entrap phosphates in times of excessive run off (Sinha, 1981). Regenerative property of the sediment is also known to play a vital role in governing the nutrient concentrations. Inorganic phosphate concentration in the present study was high during premonsoon, as also reported by Gopinathan et al. (1984), Subhash Chander (1986) and Devapiriyan (1990). Upadhyay (1988) has explained the low concentration of this nutrient during monsoon to a massive land drainage. Saraladevi et al. (1983) while studying the nutrients in the estuaries of Kerala have reported that phosphates did not show any well defined seasonal pattern. The present observations also did not show any well defined seasonal pattern.

Sankaranarayanan and Qasim (1969), Gopinathan et al. (1974, 1984), Datta et al. (1983) and Joshi (1990) have observed high silicate values during the monsoon season. The present observations agree with the above studies. The high value recorded during the monsoon may be due to the fact that the chief source of silicate is from the soil which in turn is brought down by land runoff during the monsoon. De Sousa (1983) has reported low silicates during the monsoon season and has suggested biological utilization and abiological removal by adsorption into the suspended sediments as the probable mechanisms of removal. Upadhyay (1988) suggested that dilution effect due to large river run off may have considerable influence on the lowering of silicates during the monsoon.

Diatoms constitute the major part of phytoplankton and serve as the food directly or indirectly to almost all animals in the habitat. Throughout the study period, diatoms was the dominant component in Stations II & III. But in Station I blue-green algae and green algae were the dominant groups. George (1958), Joseph and Pillai (1975), Gopinathan et al. (1984) and Preetha (1990) have reported the abundance of diatoms from Cochin backwaters and Gopalakrishnan et al. (1988) from prawn culture fields at Cochin.

FEEDING INTENSITY.

In the present study of four size groups, viz., 60-89mm, 90-119mm, 120-149mm and 150-179mm, the first one (60-89mm) showed the maximum feeding intensity in all the three stations. Devaraj *et al*. (1975) in their studies on the food and feeding habits of *E.suratensis* from fresh water tanks and estuaries in Mangalore have reported that the intensity of feeding was higher in juveniles of *E.suratensis* in estuarine environments than in freshwater tanks. They have also reported that in the estuarine environment feeding intensity was higher in juveniles, whereas the intensity appeared to be somehwat similar in all the length groups of fishes collected from freshwater tanks. The present study also showed higher feeding intensity in smaller size groups from all the Stations.

According to Sathiavathy (1989), the maximum feeding intensity was observed in the 90-120mm group both in culture ponds and backwaters. Jayaprakash (1981), while studying the feeding habits of *E.suratensis* of certain size groups from Veli lake, Thiruvananthapuram, has reported that the maximum feeding intensity was shown by specimens in the length group of 105-140mm. Prasadam (1971) also has suggested that adults of *E.suratensis* were more actively feeding than the juveniles.

Variation in the gut length of the length groups.

In the present study, the length groups I & III showed higher R.L.G. factor in all the three stations. Relative lengths of gut for different fishes with diverse feeding habits have been estimated by Das and Srivasthava (1979). They have reported that there is an increase in RLG factor for herbivorous fishes from early larval stages to adults. Thus, they have observed an increase in RLG factor of Cirrihinus reba from 306 to 894 as it grows from the fingerling stage to the adult condition. Similarly, in Cirrihinus mrigala, RLG has increased from 6.05 to 11.6, from fingerling to juvenile stages.

Quantitative data for Tilapia rendelli, Sarotherodon melanothera and Sarotherodon mossambicus in a West African Lagoon show that the ratio of intestinal length to fish standard length is between 7:1 and 10:1 (Caulton, 1976; Pauly, 1976). According to Sathiavathy (1989), the RLG factor of E.suratensis has increased from younger stages to adult. This indicates that the species gradually turns to a vegetative feeding habit from an omnivorous habit in the younger stages.

De Silva and Perera (1983) have reported that the mean relative intenstional length (m.r.i.l.) of E.suratensis is less than that of a typical herbivorous fish and varies from 1.6:3 to 7:1. De Silva et al. (1984) reported that the m.r.i.l. of E.suratensis is higher in freshwater reservoirs, where it is primarily adapted to feed on macrophytes than that in euryhaline lagoons where its food is mainly molluscs.

Jayaprakash et al. (1979) have reported that the general layout of the alimentary canal as evidenced by RLG for E.maculatus is 2.2 which confirms to that of omnivorous fishes. According to Al Hussaini (1948), the intenstinal length of omnivorous fishes varies from 0.7 to 4 times the length of the animal. From the present study, it may be seen that E.suratensis has an omnivorous feeding habit during the early stages, involving the length groups I and II. But, the length groups III and IV showed more a herbivorous habit than an omnivorous one.

Food variations in different size groups:

The food and feeding habits of E.suratensis have studied by several previous workers (Raj, 1983; Bhaskaran,1946; Job et al., 1947; Alikunhi, 1957; Hora and Pillay, 1962; Jhingran and Natarajan, 1969; Prasadam, 1971; Devaraj et al., 1975; Varghese, 1975; Jayaprakash, 1980; Costa, 1983; De Silva et al., 1984). The feeding habits of the species during different stages of its life history have also been discussed by some workers (Alikunhi, 1957; Hora and Pillai, 1962; Prasadam, 1971; Jayprakash, 1980). The results of the present study indicate that there are variations in the feeding habits during different stages of the life history of the species and the observations agree in certain respects with those of the previous workers.

Alikunhi (1957), while discussing the feeding habits during different stages has reported that the larvae feed mainly on zooplankton and switch over to filamentous algae (Spirogyra) and vegetable matter from 19 mm onwards. Prasadam (1971) in his studies from the Pulicat Lake has reported that there is difference in the food habits between smaller (40-60mm) and longer length groups (150-170mm). He found that the smaller groups predominantly feed on micro-vegetation while the longer groups mostly feed on macrophytes and other hard items. Jayaprakash (1980) has found that there is a distinct change in the food preference from diatoms and zooplankton in the earlier stages to filamentous algae in the juveniles and to higher aquatic plants in the adults. Hora & Pillay (1962) have reported that the adults mainly feed on blue-green algae and decayed organic matter. They have reported that besides vegetable matter, this species also takes zooplankton organisms such as copepods, daphnids, insectlarvae and worms. In chilka Lake, the species has been found to feed on weeds, algae, detritus, gastropods and miscellaneous items like bivalves, insects, mysids etc (Jhingran and Natarajan, 1969). In the present study, mysids and daphnids were absent.

Varghese (1975) has reported that the species is omnivorous with no change in food items among different stages. Sumithra *et al*. (1981) while studying the caloric value of ingested food of *E.suratensis* grown in culture ponds, have observed no change in the feeding habits of the species during different stages and reported that the species is principally a phytoplankton-detritus feeder. The observations made by Varghese (1975) and Sumithra *et al.* (1981) indicating an omnivorous feeding habit for the species with no change in food selection during the different stages, may be due to the fact that they may have made observations in enclosed environments, where there is no scope for a wide food selection.

According to Bowen (1981), detritus formed an important food of pond-reared *E.suratensis* and it has been reported to play a significant role in the diet of certain freshwater Cichlids. Devaraj *et al* (1975) in a comparative study of the food of juveniles of *E.suratensis* collected from estuarine and freshwater of Mangalore, have observed that detritus formed a significant portion of the stomach contents of fishes collected from both the estuarine and freshwater environments. It has been pointed out by Halver (1972) that when plant material and other food items become scarce, tilapia will eat bottom detritus mud and decaying vegetation.

According to Sathiavathi (1989) *E.suratensis* has been reported to be predominantly a macrophytic feeder in adult stages. Macrophytes like *Hydrilla*, *Elodea*, *Chara* etc were reported to be present in the stomach contents of *E.suratensis* from Veli lake (Jayaprakash, 1981). Hora and

Pillai (1962) have reported the presence of *Blyxa* and *Utricularia* in the gut contents of fishes from Chilka lake.

De Silva *et al*. (1984) have reported that the dentition and the position of mouth of *E.suratensis* shows mixed characteristics. The frontal incisiform sharp teeth are similar to those found in the Cichlid fishes such as *Tilapia rendelli*, *T.zilli* and *Haplochromis Similis*, which feed on higher aquatic plants (Fryer and Iles, 1972).

Feeding habits in different Stations:

Comparative studies of the food habits of *E.suratensis* made in different ecosystems are only a few (Devaraj *et al*., 1975; Costa, 1983; De Silva *et al*., 1984). Devaraj *et al*. (1975) in a comparative study of the juveniles from an estuary and freshwater tanks at Mangalore, have reported that filamentous algae and detritus formed the dominant food item in the stomach contents of fishes from estuarine waters, while insect larvae and detritus were found as dominant items in the stomach contents of fishes from freshwater tanks. De Silva *et al*. (1984) who have studied the food and feeding habits from an euryhaline Kaggala lagoon and a fresh water reservoir in Sri Lanka have found that in fresh water reservoirs macrophytes formed the major food items in the gut.

Bruton and Bolt (1975) have reported that in the Lake Sibaga in South Africa, Sarotheredon mossambicus adults captured in the marginal vegetation zones, feed on diatoms, vegetable debris and mud. But those captured from open waters of the limnetic zone feed on aerial insects, Coleoptera and Hemiptera. The adults of African cichlids of the genus Tilapia especially T.rendelli, T.Zilli, T.sparrmani and T.thollani feed preferentially on filamentous algae, aquatic macrophytes and vegetable matter of terrestrial origin; and also take animal food and blue-green algae in waters with poor aquatic vegetation.

In the present study, there was not much variation in the food preferences of E.suratensis in Stations II & III which are both brackish. But between the almost freshwater Station I and II the brackishwater Stations II and III, there is variation, namely in Station I filamentous algae formed the major food item in all the size groups; and in Stations II & III diatoms formed the major items.

Food preference experiment:

The quality and quantity of food can influence the growth rate of fishes to a considerable extent (Gerking, 1955; (Vijayalakshmi & Venugopalan,1973). But the feed should be acceptable to the fish cultured or else it will act indirectly as a fertilizer and may serve to increase the natural productivity of the pond, which in turn may be utilised by the fish (Halver, 1972). The importance of incorporating natural food items in artificial feeds has been well illustrated by Yashouv and Ben Schachar (1967) in the experiments conducted on Mugil capito in Israel. In these experiments percentage increases of body weight of 115.50 mg. was observed with plankton food alone; 127.0 mg. with pellets alone composed of wheat, fishmeal, soya flour containing 22% protein; and 183 mg. with pellets and plankton food together. In the present study, a natural food item Spirogyra (25%) was incorporated in the pelleted food. The inclusion of aquatic plants in the diet of fishes which are herbivorous in the adult condition have been suggested by Huet (1960), Halver (1972), Galgher (1984) and Edwards et al. (1985). Huet (1960) has pointed out that chopped grasses, water plants, algae, banana leaves, mill scrappings, bran, broken rice grain and oil cakes can be used for feeding tilapia.

The feeds usually given to cultured stocks of fishes in India include various cereal bran like rice bran and wheat bran and oil cakes of ground nut, mustard, coconut etc (Alikunhi, 1957: Sinha, 1981). The published literature on the use of supplementary food for E.suratensis in the laboratory and field conditions are those of Jayaprakash (1980), Sumithra et al. (1978), Krishnakumari et al. (1979), Anonymous (1981) and De Silva and Perera (1983). Sumitra *et al.* (1982) have reported a high specific growth rate for the species when fed on food containing 53.62% protein.

In the present observations on the food preference with four kinds of food (*Spirogyra*, *Salvinia*, pelleted feed and clam meat), the preference for pelleted feed over *Spirogyra* clam meat and *Salvinia*, indicates that the mixture containing ground nut oil cake, tapioca powder, Cod liver oil, Vitamins and mineral mix may be more acceptable for the fish than the others. Much more experiments are needed to confirm the present one.

S U M M A R Y

The present observations on the ecology and feeding habits of E.suratensis in three stations at Cochin were carried out for a period of five months from June to November, 1993. Of these, one station was almost freshwater one; and the others were brackish.

Atmospheric temperatures ranged between 27°C and 32.5°C in these stations. Water temperatures have closely followed the air temperatures and the range was from 27°C to 30.5°C in Poothotta brackishwater system (Station I), 27.5°C to 31.5°C in Edavanakadu brackishwater system (Station II) and 27.5°C to 31°C in the Narackal feeder canal (Station III), All the systems showed low temperature values during monsoon season.

The p^H values have fluctuated from 6.40 to 8.03 in Station I, 6.93 to 8.4 in Station II and 7.13 to 8.5 in Station III.

Low salinity values were recorded during the monsoon season in all the three stations. These have ranged between 0.068‰ to 0.498‰ in Station I, 0.617‰ to 4.75‰ in Station II, and 0.66‰ to 4.85‰ in Station III.

In all the three stations high dissolved oxygen values were recorded during the monsoon months between 2.73ml/L and

4.835ml/L in Station I; 2.361ml/L and 4.578ml/L in Station II; and 2.659ml/L and 4.8126ml/L in Station III.

High nitrite-nitrogen concentration was noticed during the monsoon season in all the three stations. Values ranged between 0.46 µgat/L and 1.64 µgat/L in Station I; 0.15 µgat/L and 2.2 µgat/L in Station II; and 0.70 µgat/L and 1.80 µgat/L in Station III.

In the case of nitrate-nitrogen concentration, high values were noticed during monsoon season in Stations I and III, but no such trend was noticed in Station II.

Silicate-Silicon concentration has fluctuated from 20.6 µgat/L to 58 µgat/L in Station I; 14 µgat/L to 36 µgat/L in Station II and 15 µgat/L to 36.4 µgat/L in Station III. the fluctuation was inconsistant in all the three stations.

From the water sample and soil analysis, it has been observed that diatoms were dominant during the study period, except during June and July, when filamentous algae like Oscillatoria and Spirogyra have dominated in Station I. In Stations II and III, datoms were dominant throughout the study period.

Based on the gut content analysis, filamentous algae were observed to form the major food item in Station I in all the size groups; and diatoms in Station II and III. In all the three stations gut contents were mostly made up of

Oscillatoria, Pleurosigma, Gyrosigma, Navicula, Nitzschia Amphora, Amphipora, Diploneis, Rhizosolenia, Coscinodiscus, detritus, fragments of higher plants, sand grains, miscellaneous items including roots of higher plants, fish eggs, fish scales, copepods, amphipods and gastropods. In all the three stations, smaller size groups (60-89mm and 90-119mm) were found to be omnivorous in habit whil the larger size groups (120-149mm and 150-179mm) were found to be more of a herbivorous in habit.

The observations have shown a decrease in feeding in indices with increase in size in all the three stations.

The food preference experiments on two weight groups (20g & 4g) have indicated that among the four types of feeds supplied, Spirogyra, Salvinia, pellected feed and clam meat, the preference was for pelletted feed. Also between the two weight groups, the preference varied significantly.

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